Article

Education in Sustainable Development Goals Using the Spatial Data Infrastructures and the TPACK Model

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Abstract: Education in Sustainable Development Goals is a basic step in attaining its objectives, and, therefore, it has been undertaken by broad sectors of the teaching community. Nevertheless, the "sustainability curriculum" derived from the Sustainable Development Goals, in this case based on the data of the Spatial Data Infrastructures, in spite of its teaching and research potential, is something with which the teaching body is not yet familiar. The results of the fieldwork carried out (questionnaires and Delphi technique) prove this to be the case. For this reason, in order to educate geographically in reflection and collaboration with the aims of the Sustainable Development Goals, the viewing, in a GIS on the Cloud (WebGIS) of indicators of interest is proposed for the Sustainable Development Goals taken from the Spatial Data Infrastructures within the framework of the TPACK (Technological Pedagogical Content Knowledge) model. To facilitate all these learning objectives, a proposal for good practices in the classrooms of secondary schools and another proposal for university lectures have been designed, and the results applied and analyzed. These examples demonstrate empirically that, with adequate pedagogical tools, an education in geography for global understanding by integrating Sustainable Development Goals and Spatial Data Infrastructures can be achieved, which is what the TPACK model pursues.

Keywords: geographical education; Sustainable Development Goals; Spatial Data Infrastructures; TPACK; teaching competencies

1. Introduction

The concept of sustainable development originates in the definition given by the Norwegian Prime Minister Gro Harlem Brundtland in the report "Our Common Future" (1987), which expressed the growing concern of society about the limitations of our resources and their inequitable distribution. Various initiatives have taken up this global problem, which remains unsolved (the 1992 Rio Summit, the 2000 Millennium Summit, the 2012 UN Summit on Sustainable Development Rio+20, Agenda 21, and others). In this context the UN takes the initiative in formulating 17 Sustainable Development Goals (SDGs) which, approved in 2015, should enter into force on 1 January 2016, with the aim of achieving them in fifteen years. This roadmap, which is known as Agenda 2030, includes 128 goals, a "plan of action for people, planet and prosperity. It also seeks to strengthen universal peace in larger freedom." [1]. The SDGs seek a multidimensional model of development that would guarantee sustainability. This is a complex process of political and economic discussion, with no consensus and different viewpoints, which must also be addressed through education.

Nelson Mandela stated in one of his speeches that: "Education is the most powerful weapon to change the world". In this is reflected the importance of acquiring knowledge, competencies, skills and attitudes for transforming a more and more rapidly changing world. There is a broad array of different organizations that promote this line of work, one of whose main accomplishments being the proclamation of the United Nations Decade of Education for Sustainable Development (DESD), (2005–2014), approved in UN General Assembly Resolution 57/254 [2].

Various publications demonstrate how to implant these initiatives in classrooms, for example, the "Education for Sustainable Development Toolkit" [3] now built around education and innovation ("smart") [4]. In the latter, only three short paragraphs are devoted to education, pointing out certain deficiencies to be corrected, formation being considered the fundamental base for sustainable development, as knowledge and good practices stimulate education for sustainable development (ESD). For this purpose, the tool of continuing education is offered. Other authors base the pillars of education on the SDGs dealing with the "sustainabilization" of the curriculum, a process whose aim is to educate for sustainable development by activating behaviors [5]. The Lucerne Declaration on Geographical Education for Sustainable Development [6], published by the Commission on Geographical Education of the International Geographical Union, lays the foundations of the transdisciplinary approach permitted by the SDGs, which are very appropriate in geographical education. Any professional of geographical teaching who analyzes and works in sustainable development can choose from the points of interest and treat them, using different scales, in search of an integrated development that would include the social (including political and cultural), environmental, and economic dimensions. The social aspects are related to the population. What is most important is the objective of ending poverty, which would be achieved by the distribution of wealth and the satisfaction of human necessities. The environmental aspect is concerned principally with the protection of natural resources, the alteration and degradation of the ecosystems and their diversity, climatic change, and the changes in the uses of the land. The economic aspect oversees the need to create wealth and to ensure the prosperity of the entire population.

2. Objectives and Method

Educating in the Objectives of Sustainable Development entails pointing out the problems of the present-day world as compiled in the 17 Sustainable Development Goals, not only to reflect on them, but also to activate new behaviors. It is important to build bridges between the citizenry and education, taking advantage of synergies, making compatible what is learned in the classroom with the necessities that society demands. Thus, the working objectives are based on three pillars that constitute the aspects defended by the TPACK (Technological Pedagogical Content Knowledge) model: the first would be to show the problems of the present-day world from the SDGs viewpoint, using the information of the SDIs and to look for solutions by means of viewing this information on a WebGIS; the second would be to prepare the teachers in these problems and form technological tools as a key piece so that the student can make sense of the data; and thirdly, design and experiment with interventions (good practices) that should demonstrate that all the previous objectives are possible. For this reason, the teaching staff should know the content (SDGs) and the technology for collecting, using, analyzing, processing, and sharing data [7]; this is a useful methodology for students to learn about SDGs in order to fulfill the 2030 Agenda [8]. These three objectives are those that we will develop below, following the presentation of the results of the field work in which various questionnaires have been given to active and future professors for the purpose of studying their previous knowledge in the use of the SDIs (technology) in undertaking the SDGs (content).

3. The Wealth of Data of the Spatial Data Infrastructures for Addressing the Sustainable Development Goals

The data, with its three main components–thematic, temporal and spatial–is the prime material for the territorial analysis of any phenomenon. This data located in the territory is called a geodata

(georeferenced or geolocated data). For this reason, territory, which sustains the datum, emerges with renewed importance, which the experts call neogeography [9], and whose enormous and growing volume causes many authors to speak of Big (Geo) data [10].

In this context, the citizen must learn to interpret spatial data beginning at school, and to acquire competences in using geospatial data. This is not possible without training the teachers in the use of the Infrastructures of Spatial Data (SDI). The official organisms make available the datum referenced in the territory (geodata) updated in real time, and with guaranteed inter-operability, in compliance with various harmonizing norms, standards, and specifications [11]. In this way, the "SDIs have emerged as an enabling platform that can also be applied to sustainable development challenges" thus supporting "the need to integrate geospatial information into sustainable development processes" [12]. These authors also suggested a National Geospatial Strategic Framework to integrate geospatial information into national sustainable development policies and strategies.

Obtaining data from the SDIs and integrating them into the Geographic Information Systems on the cloud or WebGIS is of great assistance for these objectives in education [13–18], because it is an excellent field for the active teaching of the use of collaborative working techniques, and it also leads to the benefits that the TPACK promotes. It has been shown that a WebGIS reinforces learning and is integrated into a novel educational current whose success in the classroom has been noted by numerous authors [19–27]. But this is not enough: in this world full of fake news [28], the students must learn as well to look for and evaluate the quality of the data, not only with respect to the precision of the location, of the attributes or of the logical consistency (relation between the layers and within the same layer), but also to the problems derived from the modifiable spatial unit.

4. The Key Piece Is the Teaching Body

4.1. Analysis of the Previous Knowledge of the Teaching Body

The evidence of the little or no knowledge of the SDIs has been made clear in a series of surveys and interviews with secondary school (Middle, Upper and High School/K7 to K12) and university professors in order to know whether or not they used the SDIs in their classrooms and lectures.

Various waves of different techniques have been applied. The first was a simple questionnaire that was answered before and after a summer course taught at the UNED and dedicated to teacher training ("Strategies for geospatial knowledge in secondary teaching", Mérida, Badajoz, 10–12 July 2017). None of the 15 who attended claimed knowledge of the SDIs before the course began. The objective of the course was to use the open data of the SDIs on the WebGIS of the platform ArcGIS online TM, Esri® (AGOL). Consequently, at the end of the course these professors not only knew what an SDI is, but they also learned to integrate its data on a web map.

In a new survey conducted in primary and secondary schools of the Community of Madrid and in Ávila, with a universe of one hundred professors (n = 100), 98% had no knowledge of SDIs. Only those who in their academic life received training in Geographic Information Systems (GIS) knew the initials, but in the informal interviews conducted, they stated that they did not use them in class because of certain problems of usability or of connection mentioned in various studies [29], in which the advantages are also pointed out.

The results of the Delphi technique, intended for professors and experts in SDI [30], showed a varied knowledge of SDIs and a certain skepticism in their use for teaching purposes, in spite of the fact that the majority of the existing geographic viewers on the Internet took their data from the SDIs.

For these reasons, we can state that the majority of the teaching staff is not familiar with the SDIs, even though they are used in many of the tools offered by geo-services or services based on geo-positioning and are very useful in employing the GPS for didactic purposes [31].

4.2. The TPACK Model

With these premises, we arrive at the TPACK (Technological Pedagogical Content Knowledge) model, designed by Mishra and Koehler [32], which adds a technological dimension to the model previously created by Shulman [33] for knowledge of the pedagogical content (PACK). None of these three elements, pedagogy, disciplinary content and technology, in itself, would produce a satisfactory learning result. We can add that the interaction of these three elements bridges the gaps between content and professors, among professors, between professors and student and among the students themselves, which facilitates the collaborative learning defended by many professors who speak of Information and Communication Technology (ICT) [34,35].

There are different initiatives in its application to the formation of teachers at different educational levels [36–39], and in different disciplines, such as music [40], and also in geography [41,42].

The model does not attempt to enrich the content and the pedagogy implemented by the evolution of technology, but, rather, it defends the concept that technology requires new methodologies and new disciplinary concepts, and vice versa. This is a complex and weakly structured task [43], which in this case requires the teachers to integrate the following into their assets: disciplinary content related to the SDGs in all their dimensions (environmental or ecological, of economic and social development, as well as adequate governance); knowing how to teach them (geographic and pedagogic education), and being able to use the technology most appropriate to achieve both ends (open geodata of the SDIs integrated into a WebGIS). All this is for the purpose of promoting reflection from the point of view of sustainable development and of changing behaviors through the competencies of critical analysis and systemic reflection [5].

Below are shown examples of the evidence of the use of the SDIs in secondary school and university classrooms as an essential source of territorial information, demonstrating that knowledge of the content is the knowledge that the teacher has constructed on the discipline that he teaches, it being possible to integrate into the geographic themes the SDGs and the data from the SDIs viewed on a WebGIS within the framework of the TPACK model.

5. Good Practices Proposal in Secondary School Classrooms

The publication of UNESCO (United Nations Educational, Scientific and Cultural Organization) [44], Education for Sustainable Development Goals, shows how key pedagogic approaches for the Education for Sustainable Development center on the student, which gives him or her autonomy and requires the detection of his or her previous knowledge, which, in this case, we have done by means of a questionnaire in the *Kahoot* application, thus connecting with gamification.

The second approach emphasized is learning oriented toward action, which is resolved by using service learning. This responds to the idea of designing an action and carrying it out in order to learn with it. This is part of the Kolb scheme [45], which commences with a concrete experience in order to observe and reflect on it, form concepts that allow generalizations and apply these abstract concepts to new situations.

And finally, transformational learning, which begins with the students' comprehension of the world and invites critical and disruptive thinking and allows co-creation of new knowledge. In all these cases the teacher's role is essential as the facilitator in this earning environment.

The conviction of the need for formation, beginning in the school, in the challenges of over-exploitation and limitation of the Earth's resources and in the social and environmental problems that are generated (2030 agenda and SDG) motivate the new and good practices in the classroom set out below. The collecting of data is carried out using the SDIs, and for the collaboration in the goals of the objectives the service learning technique is applied.

The integration of these three elements, content related to the SDGs, application of pedagogical techniques like cooperative learning and service learning, some of them including technology such as flipped classroom (videos) and the Kahoot portal (surveys and quizzes), and technological instruments

(data taken from the SDIs and viewed on a WebGIS, office automation) will lead to the achievement of the TPACK model.

The details of these good practices are:

- Title of the activity: Sustainable Development Goals through the Infrastructures of Spatial Data: from theory to practice
- Academic year: 2017–2018
- Material: Geography and history for the ESO (Obligatory Secondary Education) (ages 14–15)
- Students participating: n = 33. Percentage of boys and girls: 39% boys and 61% girls.

5.1. Objectives and Classroom Methodology

5.1.1. Objectives

1. Know how to explain concepts related to the Spatial Data Infrastructures and the Sustainable Development Goals (SDIs, SDGs, geodata, types of poverty, types of migrations, etc.).
2. Know how to use a WebGIS with the ArcGIS Online tool to integrate the geodata obtained from the SDI services.
3. Know how to prepare a report commenting on the situation represented on the map and formulate questions related to geography and the sciences whose object is the territory.
4. Know how to communicate those solutions for the problems of the world and of their city and carry out those actions that are closest.
5. Know how to work in a team, with emphasis on distribution of roles within the group (spokesperson, secretary, coordinator, and time controller) and in making decisions.
6. Know how to debate and respect the speaking time of the spokesperson of each group.
7. Respect the work of others and one's own, as well as the effort, the social responsibility and the interest in themes related to the SDGs.
8. Respect the decisions of the group or class when it comes to carrying out a social action.

5.1.2. Classroom Methodology

The following pedagogical strategies will be used to introduce and raise the awareness of SDGs numbers 1 and 2 (end poverty and zero hunger):

1. Flipped classroom technique, through the viewing of the following video: https://youtu.be/nIdXZIJvXRM, included in the EdPuzzle tool, which permits the introduction of open, true-false and multiple choice questions.
2. Individual reading of and reflection on the two SDGs to be studied in the didactic unit corresponding to "World, European, and Spanish population".
3. Cooperative learning in groups of four students, to be done in the IT classroom: creation of a map with the ArcGIS Online tool, using the SDI services provided by the web or free virtual dependable data repositories. The World Bank is recommended, but the students can select other SDI services, justifying the reliability of the geodata. After reviewing and correcting the maps, the students analyze and discuss the following map applying the outline below:

    - Introduction: brief comment on the data represented
    - Analysis of the data
    - Conclusions regarding the resolution of any problems or situations

Finally, each group prepares a reflection and smart questions for the debate on the subject of poverty and hunger. The spokesperson of each group is the one responsible for presenting the reflection and proposing the questions and possible solutions on a local and a global scale. In this case, the

actions proposed that can be carried out in their city were to go to a social dining place and collect food in the "Kilo" operation. In this process they can investigate both the origin of the goods handled as well as their distribution and commercialization in the world as global elements that do not avoid the hunger and poverty that they observe locally.

The combination of individual and collaborative activities will be presented in a portfolio in which the following objects will be included:

1.   A cooperative map with the variables related to SDGs 1 and 2, which include geodata from the SDI services (Figure 1).
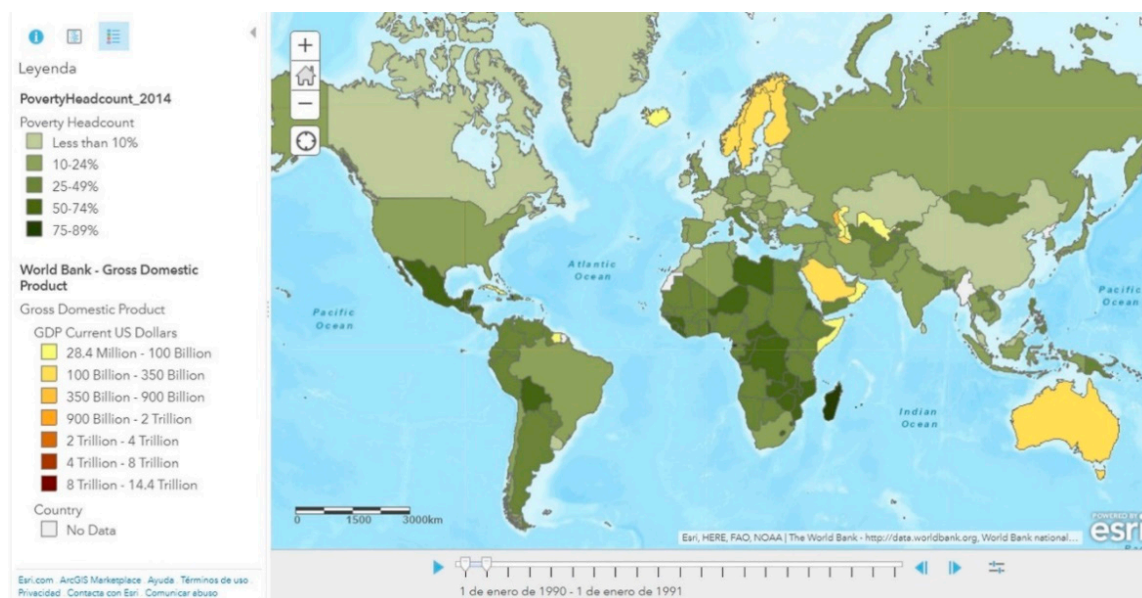

Figure 1. Mapping of a variable related to Sustainable Development Goals (SDGs) 1 and 2. Source: A group of students from 3rd ESO (Obligatory Secondary Education) (K-9).

2.   A report with the proposal of solutions to obtain the SDGs (1, 2). Analysis and commentary on the situations represented on the map, as well as reflection on the causes and consequences of poverty and hunger.
3.   Proposal of solutions on a local and a global scale. Questions for the debate.

5.2. Results of the Learning Experience and Competencies to Be Acquired Through the Proposal

The basic competencies specified by Spanish educational legislation have been applied to the results of the learning experience (Table 1). In order to do this, the educational center itself has designed a program to facilitate the calculation of the measurement of the grading of the learning standards.

It was necessary to devise headings or indicators to measure achievements in each of the competences proposed by UNESCO [46], using the adaptation done by Professor Murga-Menoyo [5], which summarizes them in four competencies: critical analysis, systemic reflection, making collaborative decisions, and sense of responsibility toward the present and future generations (Table 2).

Table 1. Learning standards and key competencies, according to Spanish educational law.

	Learning Standards (LOMCE) [1]	Key Competencies [2]
B1.1.1	Locate on a world map the continents and areas most densely populated.	CSC, CAA, CD, CMCT
B1.1.2	Find on a world map the twenty most highly populated cities, deduce what countries they belong to and explain their economic situation.	CAA, CD
B1.1.3	Explain the impact of the waves of migration on the countries of origin and on the host countries.	CL, CAA
B2.6.1	Locate on a map, using appropriate symbols and legend, the most industrialized countries in the world.	CAA, CD
B3.3.1	Write a report on the measures that try to overcome the situations of poverty.	CL, CAA, CSIEE CCEC

[1] Ley Orgánica para la Mejora de la Calidad Educativa, is the current Spanish Education Law. [2] CL: Linguistic competence, CSC: Socio-civic competence, CAA: Learning to learn competence, CD: Digital Competence, CCEC: Competence in awareness and cultural expression, CSIEE: Competence in sense of initiative and enterprising spirit, CMCT: Competence in mathematics and in science and technology.

Table 2. Indicators of achievement of the competencies following UNESCO (United Nations Educational, Scientific and Cultural Organization) [1].

UNESCO Competencies	Indicators of Achievement
Critical analysis	Ask oneself about geographic aspects (geographic questions) Identify problems of any type related to the territory Propose alternatives for improvement Do a constructive critique on the aspect observed
Systemic reflection	Understand reality at a global and a local level Interrelations among values, attitudes, knowledge, etc. Understand and reflect on the causes of phenomena, facts, and problems
Making collaborative decisions	Put into practice leadership skills and distribution of roles Participation of all the members of the working team Communicative skills to persuade or convince in arguments
Sense of responsibility toward the present and future generations	Understand the effects or consequences that an action can have in the short term and the long term Understand the consequences of inappropriate behavior that affect the present and future of the Earth Take care of intra- and intergenerational relations Contribute to the change to sustainability by adopting alternative solutions and proposing possible ones at different levels, a closer one, what can I do? Finally, a more global one, what should be done?

[1] Adapted by Javier Álvarez Otero from the UNESCO Competencies following Murga-Menoyo (2015).

5.3. Results of the Evaluation

In order to obtain the final evaluation, an evaluation at the beginning of the process is necessary (initial evaluation) in order to detect the students' previous knowledge and also a formative evaluation conducted throughout the entire process. In the initial evaluation a survey is conducted via the web application Kahoot, with seven questions (Table 3).

The majority of the students are familiar with the acronym of the Sustainable Development Goals (SDG) (81.82%), which can be attributed to the information provided in the media. They do not know the institution (UNESCO) that performed the tasks of defense, support and coordination of the worldwide action programs; many of them select the European Union as the mediator in these matters, an aspect that we could emphasize as owing to the Eurocentric view that our students have. The new date and the number of goals that have been proposed for the period 2015–2030 are not well known. We underline the fact that more than half of the respondents (51.52%) know the philosophy of the SDGs: "transform the world from any part of the world". It should be stated that the phrase "any part of the world" corresponds to any geographical location and, therefore, two questions are proposed that are to be addressed during the preparation of the portfolio: "What can we do on a local scale

(my city, my neighborhood)?" and "What can we do on a global scale (the world)?" The majority of the students (72.73%) choose the correct option in the question on what objectives are included in the 2030 Agenda (end of poverty, quality education, and gender equality), which is related to the priority that they themselves accord to the problems they feel are closer. Finally, half of the students (51.52%) see themselves as protagonists of the changes that can be made to attain sustainability, both in their own cities and in the world, while other students have their doubts (45.45%) and there are even some do not feel capable of collaborating in these changes (3.03%).

Table 3. Summary of the results of the initial questionnaire done in the classroom [1].

Questions Asked	Correct (%)	Not Correct (%)	Don't Know/Don't Answer (%)
What are the SDGs?	81.82	18.18	0
What is the institution concerned with the SDGs?	21.22	78.78	0
What is the philosophy of the SDGs?	51.52	48.48	0
Do you know what the new date is for attaining the SDGs?	12.12	87.88	0
How many SDGs are there for this new period 2015–2030?	12.12	87.88	0
Which of the following goals are included for the 2030 Agenda?	72.73	27.27	0
Do you, as a student, believe you could transform the world?	51.52	3.03	45.45

[1] Designed by Javier Álvarez Otero.

For the formative evaluation, the heading (Table 4) that completes the information from Table 1 is distributed, to be taken into account in the co-evaluation prepared among the students and the hetero-evaluation to be done by the professor. The measurement of attainment of the UNESCO competencies appears in the professor's observation notebook, which will follow Table 2.

Table 4. Heading for the evaluation of the portfolio [1].

Items	Degree of Achievement			
	4	3	2	1
Organization	Classifies, orders and files all the tasks	Classifies, orders and files most of the tasks	Classifies, orders and files some of the tasks	Does not classify, order or file any of the tasks
Presentation, order, and cleanliness	Presented very suitably, clean, and orderly	Presented suitably but with some defects in cleanliness and order	Presented, but with many errors in cleanliness and order	Presented with neither cleanliness nor order
Evidence of the learning experience	Contains all the evidence and objects	Contains some of the evidence and objects	Contains little evidence and some objects are missing	Contains neither evidence nor the objects.
Precision of the contents	Contents perfectly developed, with precision and good wording and spelling	Contents are developed normally, with correct wording and spelling	Contents little developed, with little precision and with spelling errors	Contents scarcely developed, with little or no precision and many spelling errors.
Final result	Is excellent and shows a great effort to acquire abilities and skills related to the competencies (LOMCE, UNESCO)	Is normal; shows relative effort to acquire abilities and skills related to the competencies (LOMCE, UNESCO)	Is acceptable and sufficient; shows little effort to acquire abilities and skills related to the competencies (LOMCE, UNESCO)	Is very bad or bad; shows no effort to acquire abilities and skills related to the competencies (LOMCE, UNESCO)

[1] Prepared by Javier Álvarez Otero to evaluate the portfolio.

The summative evaluation is the final average of the grades obtained by the student, which will consider:

- The co-evaluation from the valuation proposed among the working groups, based on the heading received and considering those aspects that could be improved for a future project or cooperative activity.

- The hetero-evaluation proposed by the professor, taking the heading into account.
- The individual objective test, consisting of using a WebGIS to integrate the SDI services, showing one of the realities and situations observed in the study of the SDGs.

The results obtained are shown below:

As we can observe in Table 5, all the students have obtained a grade higher than 7 over 10 (7.44), although we see certain differences between women and men, which can be explained by the psycho-evolutive differences of the students, whose basis is beyond the objectives of this article.

Table 5. Average grades for each type of evaluation and final grade.

	Women	Men	Both
Co-evaluation	7.52	7.32	7.42
Hetero-evaluation	8.26	7.39	7.83
Individual objective test	7.09	7.05	7.07
Final grade (average)	7.62	7.25	7.44

6. Good Practices Proposal in the University Lectures

Some professors are comfortable with the relation between the autonomy of the student and the orientation of the professor [47]; others see in TPACK an opportunity for distance teaching [48,49]. We have tried to integrate both views in order to incorporate the principles and values of sustainable development into the teaching project (curricular sustainability). This is a line of work promoted by the Conference of Rectors [50] itself, and which we have begun to incorporate into the university teaching (undergraduate and graduate students) in the Geography Department of the National Distance University (UNED).

To this end, various activities have been designed within the framework of the practical tasks that the students perform in some of the subjects studied at the National Distance University (UNED) (Table 6).

Table 6. Subject matter, degrees and tasks designed.

Name of the Subject	Degree (Department)	Task to Be Performed
Complements for training in the discipline of Geography	Master for professors (Geography and History)	Integrate aspects of sustainability and SDGs into the didactic unit to be designed
Human Geography	Degree in Anthropology (Philosophy)	Description of a cultural landscape to be integrated into a WebGIS with some SDGs
World Tourism Geography	Degree in Tourism (Economic Sciences)	Web map showing the sustainability of touristic destinations
Organization of Territory II	Degree in Environmental Sciences (Environmental sciences)	Web cartography of the environmental problems of the National Parks and an account of the contents of an article with Sustainable Development Goals.

Designed by Javier Álvarez Otero.

In the case of the students of the Master for professors, in the subject Complements for training in the discipline of Geography, the didactic unit to be done is the required work of the subject, and it should include aspects of sustainability related to the SDGs and the area of geography undertaken. The students whose final dissertations were directed in the academic year 2017–2018 have included aspects of sustainability. These students have shown their satisfaction at having been introduced to this line of work, which indicates that it is a correct approach.

The students of Anthropology, in the subject Human Geography, must do a complete description of a cultural landscape of their choice, which they must relate to the SDGs that they consider most relevant and must add a resume to a web map (using the Survey123 tool). The result will be a

collaborative WebGIS map to which will be added other layers of information from the SDIs in order to gain further insight into the relation between the phenomena studied.

The students of the Degree in Tourism, in the optional project for the subject World Tourism Geography, will use Survey123 to evaluate sustainability in the number of visits to great world touristic destinations, the result being a map containing all the information.

In the academic year 2017–2018, in the subject Organization of Territory II, the students for the Degree in Environmental Sciences did a study on the National Parks and the problems of sustainability detected in relation to the SDGs. In the 2018–2019 academic year a map has been created with the information on the parks available in the Infrastructures of Spanish Spatial Data (ISSD), to which the students will add their reflections on the environmental problems of these natural areas as they relate to sustainability and on actions for improvement of the SDGs. Given some of the problems encountered in the location, it was decided to use the Survey123 tool, which facilitates the creation of the layer of information by registering the data of the survey conducted at the site data that the student situates on the said map. Furthermore, the students will do a critique that they will review among themselves (double-blind pairs) on an article relevant to the organization of the territory and the SDGs from among a list provided by the teaching team.

Another area of application was the UNED summer course for professors given in July 2018 was flipped teaching and geolocalization for learning geography in the cloud. It included an obligatory activity in which the students had to present their surroundings to their classmates, making reference to some concrete element of sustainability. For this purpose, a questionnaire is used that permits georeferenced points to be included (Survey123), and makes it possible to show the results on a web map. In general, the students have been satisfied with the activity, which is still in the process of completion.

In the project those surveyed were to relate the WebGIS and the SDGs, reflecting on one of the subjects that are taught or will be taught in the future, with the idea of integrating into it the Objectives of Sustainable Development (SDGs). Also, there is a requirement to design a web map that can serve to improve the knowledge of these objectives, directed at looking for actions for improvement.

These tasks have attempted to cover at least the following goals:

1. An improvement in the work done by the students in relation to cartographic visualization and the contents related to the SDGs.
2. Create a form of working and of communicating the competencies, which encourage responsibility for future generations that the SDGs promote through the WebGSIs.
3. Initiate a working model that can gradually be expanded and extended to other subjects.

In all these cases the aim is for the student to know the existence of the 17 SDGs, (although it may be impossible to address them all in just one academic year), and to reflect on some of them and to begin to understand the importance of sustainability, so that responsibility toward future generations may be fostered by means of a reflexive approximation to the territory through geography. In this process, it will be fundamental to invite the student to ask himself or herself questions from geographic science that could foment the creation of a critical spirit along the lines of what the 2030 agenda should achieve through socio-economic, technological and educational advancement, for example: how to feed the 8.563 million people who will constitute the planet in 2030 in a context of climate change, economic and financial uncertainty, and increasing pressure on natural resources.

The indicators that will serve to evaluate the results will be:

(a) The level of satisfaction of our students, who will answer a question on it, and will progress in themes of cartographic visualization, in which probably, according to the replies of former years, around half of them will not have worked before.
(b) The level of satisfaction of the professors, who will thereby obtain a better integration among teaching teams and tutoring professors.

(c)   Knowledge and awareness of the need to attain the goals of the SDGs, which will be observed through the tasks performed.

(d)   Transmission of the knowledge acquired to their own students and/or other students.

7. Discussion of the Results

The results ratify the need to improve the territorial knowledge on which are based the goals of the SDGs as well as the importance of using reliable, up-to-date sources such as the services offered by the SDIs.

The professors must face the challenge of the ICT and take advantage of them in benefit of more efficient teaching. Beyond incorporating them into what was being done before, a transformation is proposed that integrates the three aspects indicated: disciplinary, pedagogical, and technological, into the acquisition of disciplinary (CK), pedagogical (PK) and technological (TK) knowledge which integrates pedagogical disciplinary knowledge (PCK), technological disciplinary knowledge (TCK) and technological pedagogical knowledge (TPK). All of them participate in the construction of TPACK, which permits disciplinary objectives to be attained with the proper use of the integrated pedagogy and technology.

Thus, new knowledge is created that will help the students in their development both professional and as citizens. In this study it has been applied to a better knowledge of the SDGs, which it is possible to do by using the geodata of the SDIs viewed on a WebGIS.

Of the suggestions on aspects to be introduced in the formation of professors that permit good practices of this kind in the classroom, one is integrating aspects of geolocalization and SDI related to the SDGs and the contents of the curriculum in a natural way, as has been shown here for secondary and university education.

Although the proposal is still in the early stages, it has been considered perfectly feasible in the University Master in Formation of Professors of Secondary Education of the UNED and other universities; it could even be applied to the permanent formation that the active professors must complete. In this way, it would easily reach the secondary school classrooms and promote the university–secondary school relation, very necessary because of the valuable retro-alimentation it provides. Furthermore, with this proposal we are contributing to two areas of priority action of UNESCO [51]: "Transform the environment of learning and formation" and "Create capacities among the educators and trainers".

8. Conclusions

Our proposal of educating in the Sustainable Development Goals as a means of collaborating in their advancement merges with the TPACK (Technological Pedagogical Content Knowledge) model, bringing together the intrinsically interrelated disciplinary, technological and pedagogical content.

We consider that this proposal is innovative in its disciplinary aspect because it is a new way of approaching content and reflections on the Sustainable Development Goals; in its pedagogical aspect because it requires new methodologies, some of them collaborative; in the technological aspect because it uses Spatial Data Infrastructures and a technology available since 2012 (WebGIS of ArcGIS Online). In this study there are examples proposed of the classroom in relation to secondary school students and also to university students, and in addition, the difficult topic of the formation of the professors is treated, a key matter for the transformation of teaching necessary for the citizenry of the 21st century.

TPACK and Spatial Data Infrastructures join for the purpose of favoring territorial knowledge and improving the competencies of the students, future professors, living together in a technological environment and a society ever more demanding of up-to-date data, within the phenomenon known by all as Big Data; in this case for a better knowledge of the Sustainable Development Goals and the initiation of actions in order to reach the proposed goals. The usefulness of cartographic language in a WebGIS to express the Sustainable Development Goal has been demonstrated, based on the needs and motivation of our students.

What has been achieved is that the student knows and is involved in achieving the Objectives of Sustainable Development, using the data of the Spatial Data Infrastructures viewed in a WebGIS, and contributing good classroom practices extendable to other places and centers. An important feature is the use of a variety of pedagogical strategies and techniques, such as the proposals that permit the student to be the protagonist of his or her own teaching–learning process from the beginning, with an experiential focus (flipped classroom), passing through practice (learning based on problems) and proposing solutions to what he or she is familiar with, thus providing a service to his city (learning-service).

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