

What do Law and Mathematics have in common? The Sustainable Development Goals as a Transversal Substrate of Numbers and Laws

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Abstract- This paper presents two experiences of innovative teaching at the Public University of Navarra that have as a fundamental common link: the mainstreaming of the Sustainable Development Goals in the curriculum. With this objective in mind, the subjects International Law and Mathematics, that are a priori conceptually different, can be worked on at a competency level with the same common challenge. This challenge consists in promoting the exercise of global citizenship, active, supportive, responsible, and committed to sustainable development. For both experiences, some of the activities carried out with this objective are described, contextualized in the framework of the Sustainable Development Goals (SDGs). The main conclusions drawn from the experience are analyzed, highlighting the fundamental role of universities as a driving force for social transformation from different dimensions.

Keywords: *SDGs, Agenda 2030, international law, mathematics, global citizenship, transversal competences*

1. INTRODUCTION

The 2030 Agenda for Sustainable Development is one of the most ambitious global agreements reached by the United Nations to address the most pressing global challenges: ending poverty, combating inequality and injustice, and tackling climate change.

Undoubtedly, the Sustainable Development Goals (SDG) need their place in universities because, as centers for the generation and dissemination of knowledge, they must serve society and actively support the achievement of goals related to teaching and learning, research, social leadership and institutional governance (Heleta & Bagus, 2021).

In this sense, the Public University of Navarra is immersed in various projects related to the implementation of the SDGs in those aspects in which higher education can contribute in an innovative way.

In this paper we present some experiences from two different points of view: the subjects of Mathematics and Public International Law, in which the authors have made room for the analysis, deliberation and implementation of different aspects of the SDGs, in order to familiarize students with the challenges promoted by the 2030 Agenda proposed by the UN.

The consideration of the importance of the SDGs in subjects as disparate as Mathematics and Law highlights the

transversality of the global challenges posed by the UN, the ambition of the goals to be achieved and the significance for different areas of society. These extremes represent an added value for higher education institutions when addressing the study, research and promotion of the SDGs.

The connection between these two experiences in subjects that at first sight seem so divergent, lies in the fact that the authors of the paper participate as professors in the course Development and International Cooperation, which has allowed us to delve into the 2030 Agenda from a more global perspective. In an exercise of continuous feedback, this circumstance makes the two teaching areas mutually enriching. From an innovative institutional experience designed taking into account the challenges set by the 2030 Agenda for universities, other teaching-learning tests were generated that are more related to our respective areas of work and research, which in turn translates into a tangible connection between very different subjects, but which are linked by a firm commitment to the SDGs.

2. CONTEXT

The overall objective of both innovation experiences would be the knowledge of the SDGs by our students, offering them training in values and techniques in order to promote the exercise of a global citizenship, active, supportive, responsible and committed to sustainable development.

If our society is to change in order to achieve the goals proposed by the UN, it is essential to provide future generations with the necessary skills for participation and social transformation (Crespo, 2017).

On the one hand, in the case of Mathematics, the main objective is the development of the challenges posed by the SDGs through problem solving, encouraging critical analysis of the results obtained in them. Special emphasis is placed on training students in strategies to address problems that may arise in the future, in which the challenges that society will face require quantitative knowledge of the relevant variables.

On the other hand, in the case of Public International Law, the global approach of the 2030 Agenda by the United Nations Organization provides an excellent opportunity to know, analyze and relate the concepts, legal sources, and actors of the main scenario where the SDGs are deployed (Durán y Lalaguna

et als, 2016). After that, and starting from this global perspective, we try to go down to the particular scene to expose concrete cases of application of the SDGs that allow a problem-based learning. In this case, knowledge is qualitative, hence the complementarity between the analyses carried out in the context of both subjects.

3. DESCRIPTIONN

A. Innovative experience in the subject of Mathematics

In the subject of Mathematics, the experience is being worked on with the students of the International Program of the Degree in Business Administration and Management and the International Program of the Double Degree in Business Administration and Management + Law, who share a group in this subject. Every week they have a 2-hour practical session where the student's activity is the central element, the knowledge adopts the structure of a problem and its acquisition depends on the elaboration of its solution by the student. It is considered of special importance to try to make the student responsible for his learning process and also to deepen his "mathematical responsibility". In other words, the importance of analyzing the results obtained, verifying their coherence and that they do indeed provide a solution to the questions posed, is emphasized in several ways. This context offers an optimal framework for incorporating the Sustainable Development Goals through problem solving, contextualizing each of the mathematical concepts and results to be worked on according to the course syllabus, within the framework of one or more SDGs. Below are some examples of this, for each of the thematic blocks of the subject.

In 2011, The Swedish Institute for Food and Biotechnology (SIK) published a report about the total food loss and waste around the world. It was estimated that the food waste per person per year by consumers was 5 kg. In Sub-Saharan Africa, 25 kg. in Latin America and 90 Kg. in Europe. Taking these figures into account and assuming that they are not only an average estimate but that they correspond to individual waste, a study was carried out with a group of 14 individuals and it was obtained that the total food waste of the group was 400 kg. Can we deduce how many individuals from this study come from Europe, how many from Latin America and how many from Sub-Saharan Africa?



Fig. 1 Problem presented for learning systems of linear equations

After t hours since the discharge of a toxic substance into an aquatic ecosystem, the number of liters affected by toxicity is given by

$$T(t) = \frac{t^3}{3} - t^2 + 8t + 30 \text{ liters.}$$

What was the maximum and minimum value of liters affected during the first six hours? At what times did these extreme values occur?



Fig. 2 Problem presented for learning optimization of functions of one variable

A sustainable and responsible investment program generates a profit estimated as $R_1(t) = 10 + t^2$ euros per year (here t measures the time, in years). An alternative program generates a profit given by $R_2(t) = 12 + t$ euros per year.

Evaluate the period when the second plan is better than the former one.

Which is the mean difference of profit of this second plan vs. the first plan along the period in which the second plan produces the higher profit.



Fig. 3 Problem presented for learning definite integrals

B. Innovative experience in the subject of Public International Law

As for the subject Public International Law, although the syllabus follows the contents defined in the report approved prior to the global agreement on sustainable development, in most of the lessons the teaching/learning of the SDGs can be introduced, favoring the assimilation of the main concepts and the acquisition of competencies and skills in sustainability, global citizenship, equity and protection of human rights.

Through case studies, the analysis of international standards, the questioning of global problems, the viewing of documentaries (some made by the UN), jigsaw or Socratic dialogues, the SDGs are present in many practical sessions, flipped classroom exercises, and simulations of trials or proceedings before international organizations.

Let's take a concrete example that is being developed in class during the current academic year for students of the International Program of the Double Degree in Business Administration and Management + Law: the viewing of the documentary entitled "Nations United: Urgent Solutions for Urgent Times". It is a documentary created by the organization itself on the occasion of its 75th anniversary and with which it also wants to focus on the 5 years since the approval of the 2030

Agenda. The documentary is based on the rupture in our daily lives caused by the Covid-19 pandemic and takes the opportunity to remind us that the foundations for ending poverty, inequality, injustice and climate change are laid in the SDGs, so all that is needed is decisive action by all to follow a difficult path, with numerous obstacles, but not uncertain.



Fig. 4 “Nations United: Urgent Solutions for Urgent Times” Documentary

The documentary is relatively long, but it is not viewed in a single day, as it has the advantage of being clearly divided into five parts: (1) the first is introductory, so it is seen in a very early session of the course, (2) the second is dedicated to climate and all the SDGs that have to do with the environment, (3) the third deals with poverty and inequality with special emphasis on the vulnerability of some groups, (4) the fourth focuses on justice and human rights, so it fits perfectly with the part of the subject agenda where the international protection of these rights through treaties and specialized agencies is addressed; and, finally, (5) the fifth part refers to gender equality, to which the UN dedicates exclusively SDG 5, although it may be relevant to almost all the sustainable development goals.

With the first part of the documentary we presented the 2030 Agenda for Sustainable Development. Thus, in this session we carry out a previous practical exercise that consists of capturing on paper a few telegraphic ideas of what the students already know about the SDGs; each group reads their ideas aloud and then we visualize the introductory part of the documentary. After the viewing, a discussion begins, in the form of a Socratic dialogue, to try to improve the ideas that are already written and add those that are missing, but appeared on the screen. The document is not amended; it is rather a portfolio where new knowledge will be added with clear and concise concepts, easily comparable with those previously included.

Thanks to the second part of the documentary we approach the so-called Climate Summits and their results, highlighting the difference between hard law instruments and soft law instruments in Public International Law. We also approach the diplomatic techniques of negotiating treaties and other international norms, as well as the checks and balances of global geopolitics. The analysis of some of the emblematic provisions of the historic Kyoto Protocol of 1997 or the clauses of the Declarations of the most recent summits constitute a very interesting practical exercise for future lawyers, who are expected to discern between what is legally enforceable and what is not.

The third part of the documentary is dedicated to people under International Law. It is used to draw attention to the migratory phenomenon and the special vulnerability of some groups in these circumstances (children, refugees, stateless persons). The rescue of migrants at sea and their international regulation - as opposed to the xenophobic discourses that seem to advocate the interception and closure of these vessels - is the theme chosen to address, through a mock trial, the international responsibility of the State, the application of the Law of the Sea, and the design of an effective development cooperation policy that takes into account the needs of the migrant' countries of origin.

The fourth part is the easiest one to deal with in a law degree course, since it refers to justice, but it should also be remembered that the international protection of human rights is a substantial section of the course syllabus itself. In this area, we present the instruments and control mechanisms to guarantee these rights existing worldwide, both at the UN and regional levels. Likewise, we highlight their limitations, encouraging our students to submit proposals for their improvement. Through the realization of a jigsaw puzzle, to which all students are called to contribute with pieces, they will have to decide which are the procedures they would advise to a supposed client seeking legal advice, who has had one of his fundamental rights violated.

The fifth part of the documentary can be approached from the perspective of human rights and particularly vulnerable groups, in this case women. The 1952 Convention on the Political Rights of Women, the 1979 United Nations Convention on the Elimination of All Forms of Discrimination against Women, and the 2011 Budapest Convention on Preventing and Combating Violence against Women and Domestic Violence constitute the fundamental international regulations on the subject, whose analysis -together with the jurisprudence to which they have given rise- is a significant training for our students. Likewise, the practice in this sense can be focused on a comparative law exercise in order to check to what extent the domestic legislation of the States, which have expressed their consent to be bound by these treaties and have undertaken to adapt their legislation to them, actually comply with them or not, and to what extent the case law is able to correct the deviations.

4. RESULTS

In the subject of Mathematics, the experience has allowed us to incorporate the cross-cutting knowledge of the SDGs from the first year of the degree, as well as to provide students with the necessary skills to be active agents in addressing the challenges posed by the SDGs. In this sense, it allows them to develop their critical capacity, understand the scope of "mathematical responsibility" and allows them to break the artificial barrier, which they themselves generate, of distance between what they learn in the classroom and reality.

The results obtained through the experience have been very satisfactory and encourage us to continue along these lines. On the one hand, working on problem solving within the framework of the SDGs has meant that students are more actively involved in these practical sessions, and this has also been reflected quantitatively in a significant improvement in the results obtained in previous years when this approach was not used. Thus, the percentage of students who passed the course

has gone from 54.8% of those enrolled in the 2019/2020 academic year to 94.6% in the 2020/2021 academic year.

In turn, the experience in the subject of Public International Law has ensured that future jurists, whether national or international, are familiar with the SDGs. They are able to approach them with logical reasoning and a critical sense, applying legal, jurisprudential, and doctrinal sources to the legal dilemmas of a society in constant transformation. We are aware that, in the near future, our students will be in charge not only of drafting and implementing regulations, but also of designing public policies and managing private entities. For that reason, we felt it was urgent to develop their skills, training them in values and tools designed to foster a global citizenship committed to multiculturalism, sustainable development, efficient use of resources, solidarity, equity, justice, and the defense of human rights.

The impact of the treatment of the SDGs as a cross-cutting theme throughout the semester can be measured through student participation in the weekly practices. Here we find that, in the current 2020/21 academic year, 96% have actively participated in the development of the proposed items, compared to an average of 86% in previous years, which represents an increase of 10%. While it is true that the overall number of students does not vary too much (3 students), the result is positive as we have managed to get a few more students to follow the continuous evaluation of the subject while approaching the knowledge of the goals of sustainable development.

As for the final evaluation of the whole course, which takes into account both the weekly practices and the exam, we can also show our satisfaction since only very few students do not pass the course (2 students: one failed and one not presented), while 96.55% pass it. It may be striking that no student achieves the grade of outstanding, but this is due to the final exam, not to the continuous evaluation, where they usually get higher grades.

5. CONCLUSION

Education is an essential tool for achieving the Sustainable Development Goals. The university, as an institution of higher education, must actively contribute to achieving the goals proposed by the 2030 Agenda both from the point of view of the training offered, as well as from the research perspective. Likewise, we have no doubt that the university will benefit from committing to the SDGs, while at the same time exercising its rightful role as a driving mechanism for social transformation.

Aware of the magnitude of the challenge of meeting the SDGs, the Public University of Navarre has developed some actions in order to play the crucial role that an institution of higher education must have in contributing to that challenge. As we have already mentioned, the offer of a course on Development and International Cooperation highlights the institutional will to present a transversal training. Thanks to this course, any student of the university has the opportunity to become familiar with the values, concepts, and tools necessary for the achievement of the goals outlined by the UN. But this experience has also given rise to the challenge for teachers to assimilate the content of the SDGs in their areas of knowledge.

At the individual level, a significant number of teachers have already begun to design theoretical and practical content in order to provide our students with the necessary skills to

become actively involved in achieving the SDGs. In line with the possibility of aligning final projects with the SDGs, which has been proposed by the university for the first time in the current academic year, the authors have offered and directed projects related to the 2030 Agenda. Below are some of the titles of the final degree projects we have worked on in recent years:

- “The role of Mathematics in achieving the SDGs”
- “The soft law nature of the climate change regime: special reference to the Paris Agreement”
- “Gender Equality from an International Perspective: Sustainable Development Goals”
- “Peace, justice and Strong Institutions: Goal 16 of the 2030 Agenda”
- “Refuge and the right to asylum: the case of migrant women”
- “The Stateless Rohingya from Myanmar: A Legal Analysis”
- “Refugee Protection in International Law”
- “From the Commission on Human Rights to the Human Rights Council”

As for the offer for the 2021/2022 academic year, these projects have been proposed with the following titles:

- “Trafficking and migration”
- “Migration and Climate Change”
- “Balance between economic growth and environmental impact”
- “Sustainable finance”

The offer of final projects on issues related to sustainable development is aligned with the University Strategic Plan 2020-2023, as well as with the specific strategy of the School of Economics and Business Administration, which points out these strategic actions:

- To promote the commitment of students and faculty in social and sustainable development projects, aligned with the cooperation policy of the University and the Government of Navarre.
- To be a framework for the promotion of sustainable development actions.
- To work so that students, teachers and administrative staff have an ethical commitment in the development of their activities, and to empower students by providing them with the knowledge, skills and ways of action necessary to be responsible and supportive citizens, and effective agents of positive change today.

In this paper we have wanted to present two subjects that, in principle, may seem diametrically different: Mathematics and Public International Law. However, we have managed to highlight that the SDGs can be present in the vast majority of subjects within any of the degrees and postgraduate programs offered at our universities.

Based on the present experience, in addition to continuing to address the SDGs in our respective subjects and in the final projects we supervise, we also intend to launch a legal-mathematical laboratory, which could pose a challenge to be achieved through a project to be developed throughout the semester. The laboratory itself could also give rise to the realization of final projects co-supervised by both authors, combining mathematical and legal analysis of certain phenomena linked to the SDGs.

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