

Article

Inventory and Analysis of Environmental Sustainability Education in the Degrees of the University of Alcalá (Spain)

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Abstract: In order to promote education in environmental sustainability at higher education institutions and establish action priorities, a detailed analysis of the initial situation is needed, both in terms of courses offered and teaching and assessment strategies implemented. This article presents a methodology that can be used to standardize the evaluation of teaching in environmental sustainability at different universities. We exemplify its application at the University of Alcalá, located in Central Spain. The inventory was conducted using in-house software development for the extraction of environmental sustainability concepts in the degree courses' syllabi, completed with a survey to faculty members and a manual review to confirm its adjustment to environmental issues. Those finally selected were analyzed in depth. The main results indicate that currently, only a small part of the courses (5.5%) offered at the University explicitly include environmental sustainability content. The grades that concentrate most of the courses are those of Environmental Sciences, Biology, Economics, Tourism and Pharmacy, with very low occurrence in the grades of Education and Health Sciences. It is concluded that further institutional commitment is needed in the definition of medium-term strategies to guide the training and dissemination efforts in order to promote sound environmental education in university courses.

Keywords: higher education; education for sustainable development; degrees; syllabi; University of Alcalá

1. Introduction

It is widely accepted that education plays a critical role in environmental education [1]. As it was indicated by the pioneer conferences on the environment (Stockholm, 1972), universities have relevant roles in sustainable education, as they provide the basic scientific basis to understand environmental problems and solutions. In chapter 36.3 of the 21 Agenda approved in the Rio Summit of 1992, UN countries acknowledged that “education has a critical importance to promote sustainable development and to increase human capacities for understanding and tackling environmental issues”. In 1993, the European

countries signed the Copernicus treaty, which created the European University Network for Sustainability [2]. This agreement included the commitment to incorporate concepts of sustainable development to all university degrees. At the same time, the Kyoto declaration signed by the International Association of Universities recommended the inclusion of sustainable practices in all university campuses, along with the development of a dedicated strategic plan on sustainable education concepts. During the Johannesburg Summit in 2005, the UN launched the *UN Decade of Education for Sustainable Development* (2005–2014), which aimed to integrate environmental principles, values and practices in all aspects of education and training. This process was further reinforced with the approval of the UN Sustainable Development Goals (SDG) for the 2015–2030 period. Actually, SDG ODS 4, “Quality Education”, includes a dedicated target to “... ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development” (target 4.7). Currently, the seriousness of the social, economic and ecosystemic consequences of changes of mainly anthropogenic origin make it essential to have an education that holistically and transversally addresses the socioenvironmental crisis and prepares citizens and professionals capable of giving an adequate response to the challenges that arise [3,4].

The specific activities aimed to support this goal may be quite diverse, but it is obvious that they require an increasing effort to introduce environmental issues at all levels of education, including university degrees. The range of international initiatives related to this target is very diverse [5–12]. Most of these studies emphasize the need to extend environmental education to all degrees, not just to particular courses, as it is recognized that sustainability affects all sciences. Although there have been improvements in the implementation of sustainability in higher education, there are still numerous challenges to be faced [13,14], including the integration of sustainability in curricula and research in a holistic and transversal way [7] (p. 93).

One of obstacles to incorporating environmental concepts in university degrees is the lack of information on the exact extent that these concepts have in the university curricula, as well as their temporal trends. In addition to the absence of quantitative instruments to monitor extent and trends of environmental education, another problem lies on the exact definition of sustainability, which is a broad concept that also includes other dimensions that are not directly linked to environmental issues.

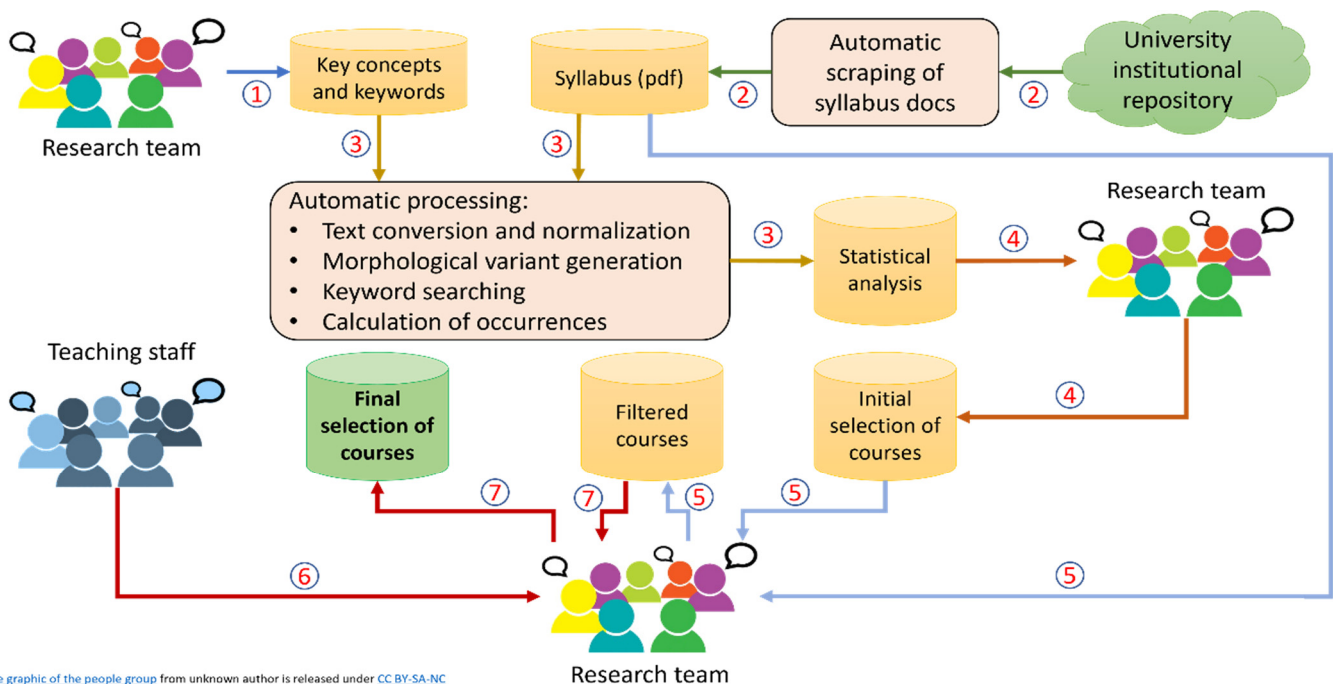
Obviously, the first step to improve environmental education is a sound assessment of the initial situation, which implies quantifying the number of courses and the topics covered. This would facilitate detecting gaps and potential overlaps [14]. Even though some previous studies had analyzed the environmental concepts mostly covered by university degrees in some Spanish universities [15], they were based on the description of the degrees, rather than on the actual education courses being offered by the different institutions. An analysis of educational competences was also published in [16], but again not connected to the actual extent of environmental education in the university. In [17], the authors revised the environment-related competences by analyzing the documents that Spanish Universities must present to the authorities to have their grades authorized to be taught. More recently, Calero et al. analyzed the syllabi of a single master’s degree, focusing on mentions of sustainability concepts [18]. Another study on the curricular implementation of topics linked to the SDGs conducted at the International University of Catalonia [19] shows the difficulties expressed by the academic staff of that university. We have not been able to find similar studies at the international level, but the common strategy in all the reviewed works is a qualitative one, by manually analyzing the situation of environmental education in their institutions. This fully manual approach makes it difficult to extend the analysis to broader contexts.

This paper aims to describe a simple methodology that could be used to quantitatively and qualitatively evaluate the extent of environmental education in a university by first automatically identifying the courses that are candidates to deal with environmental content versus all offered in a particular academic year, and then further exploiting the results with a manual qualitative analysis. This method could be applicable to any university to compare its situation with other higher education centers in a particular country or region, as well as to analyze the temporal trends. The method was tested in the University of Alcalá (UAH), located in the region of Madrid (Spain). It is a state university funded in 1977 which now hosts around 21,100 students, 16,500 undergraduate and 4600 graduate.

Our study was based on the analysis of the syllabi for every course offered in our university. These documents indicate the contents of the course, the main methods used in teaching and evaluation and the recommended bibliography to follow the course. Since they are official guides provided by the professor in charge of the course, they should be considered as binding documents to describe the course contents. Therefore, they are the most accurate sources to assess the exact content and extension of the topics covered by each course. This paper describes the methodology that we followed to carry out the inventory of environmental courses offered by the University of Alcalá, along with the topics covered and the strategies used to grade them. Our approach should be used for other university institutions that aim to assess the status of their portfolio in environmental education.

2. Methods

Since we aimed to develop a quantitative assessment procedure that could be applicable to different university institutions, we developed a semi-automatic procedure to extract the environmental concepts from all courses' guides offered in our university. After a first automatic inventory, a second manual revision by different academic specialists was carried out to refine the search by including or excluding some courses that might have been improperly selected. Finally, the survey was complemented by a dedicated questionnaire with professors of the selected courses. The methods are summarized in Figure 1, in which numbers are used to ease the location of each element in the following description.



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Figure 1. A block diagram of the applied methodology, including the processes, data used and/or generated and participation of the research team and teaching faculty. Numbers ① through ⑦ are used to be referenced from the text.

The starting point of our assessment was the definition of a set of environmental concepts covering all disciplines. The starting point was a list of sustainability concepts previously published by Aznar et al. [20]. From those concepts, those more closely related to environmental issues were kept, and a few were added considering recent developments of different disciplines. The final list of 20 concepts is included in Table 1 ①.

Table 1. Concepts used in the search.

Acronym	Meaning
AMB	All environmental
BIODV	Biodiversity
CLIMN	Climate change
CNSE	Conservation of the natural environment
ECO	All economic activities related to the environment
EREN	Use of renewable energies and energy efficiency
ETAMB	Environmental ethics
GESTAM	Environmental management
HUMAMB	Environmental humanities
IMPCT	Assessing the environmental and social impact of economic activities
INFHU	Human influence and intervention in the environment
PROAM	Global environmental problems. Disaster prevention and mitigation
PROCON	Responsible production and consumption. Social and environmental effects of consumption habits
RECURNA	Natural resources: protection and sustainable use of natural resources indispensable for life
REMED	Use of means by human beings to remedy environmental damage caused by themselves
RURL	Rural transformation
SOSTENB	Generic Sustainability
URBN	Sustainable urban planning
TECAMB	Environmental technologies

These concepts were used to classify the topics covered in the different syllabus documents of the selected courses, but they were too general to carry out our automatic search. Therefore, based on these concepts we created a list of 102 keywords ①. They were more specific terms that would likely appear in courses related to environmental issues. These keywords were also better adapted to the automatic search to be found in each course syllabus. For instance, from the general concept of *Climate Change*, we created more specific keywords, such as *carbon footprint*, *atmospheric emissions*, *global warming*, *mitigation policies*, etc., more likely to be found in the guidelines than the simple one of climate change, which was also kept. The definition of these keywords (the full list of translated keywords and their associated concepts can be found in Annex 1 of <https://bit.ly/3yghwds>, accessed on 1 June 2022) was greatly benefited by the interdisciplinary character of our research group, including economists, geographers, chemist, lawyers, environmental scientists, engineers, biologists and philologists.

The selection of courses offering environmental concepts was done by dedicated software that searched the presence of keywords in the syllabus documents of each course offered by the University of Alcalá ①②③. A total of 2702 courses were offered in the academic course 2018–2019, from which 2,183 guides were available in the institutional repository of the university ②. The remaining 519 were either not available or not offered in that particular year. The automatic search included the following processes ③:

- Conversion of the documents' PDFs into text format.
- Text normalization (all capitals were converted to plain text, removing accents and other non-alphabetical characters, etc.).
- Generation of morphological varieties of the keywords (variations in genre and singular–plural)
- Search of the different varieties and computation of their frequency of occurrences.

For each course, we computed the number of different keywords found, the total frequency of keywords and the number of concepts. A first selection of courses was done by extracting those that had at least two different concepts covered or two keywords ④. A total of 113 courses were selected by this first classification.

A manual review followed this selection ⑤, as some courses might have been selected from a marginal coverage of the keywords or covering them with a different meaning, not closely related to environmental sustainability. In addition, we ran a survey to the university teaching staff ⑥, asking them to complete our initial selection with their own judgment on whether their courses could be considered or not as offering environmental content. Additionally, we merged those courses that were offered in different degrees to avoid duplication ⑦.

With this second evaluation step, a final selection of 99 courses was obtained (120 courses if we would consider courses offered in more than one degree). These 99 courses were reviewed by the different thematic experts, extracting from the syllabus content the course type, whether they were mandatory, optional or cross-curricular (that is optionally offered to different degrees), the teaching modality (online or not), the main concepts covered (from Table 1) and the three main educational strategies and evaluation methods used. As the educational strategies, the following were considered: seminars, field work, flipped class, problem-solving classes, case studies, oral presentations, text analysis, service-learning and visit to companies-institutions. Finally, evaluation methods that were considered included written exams, oral presentations, fieldwork notebooks, labs and written essays.

3. Results

The 120 courses with significant environmental concepts that were finally selected only accounted for 5.5% of all courses offered at the University of Alcalá in the 2018–2019 academic year. From these courses, 40% were mandatory, 52.5% were optional and 7.5% were cross-curricular. This implies that only a minor number of students were offered environmental courses, considering the small percentage of environmental courses and their optional character. Out of all these courses, most lasted only one semester (67%).

Figure 2 includes the distribution of courses addressing sustainability concepts, organized by university degrees. As it may be expected, the degree with the highest number of courses was Environmental Science, which included 23% of all environmental courses of the university. It was followed by degrees in Pharmacy, Biology, Tourism, Architecture and a double degree in Tourism and Business Administration.

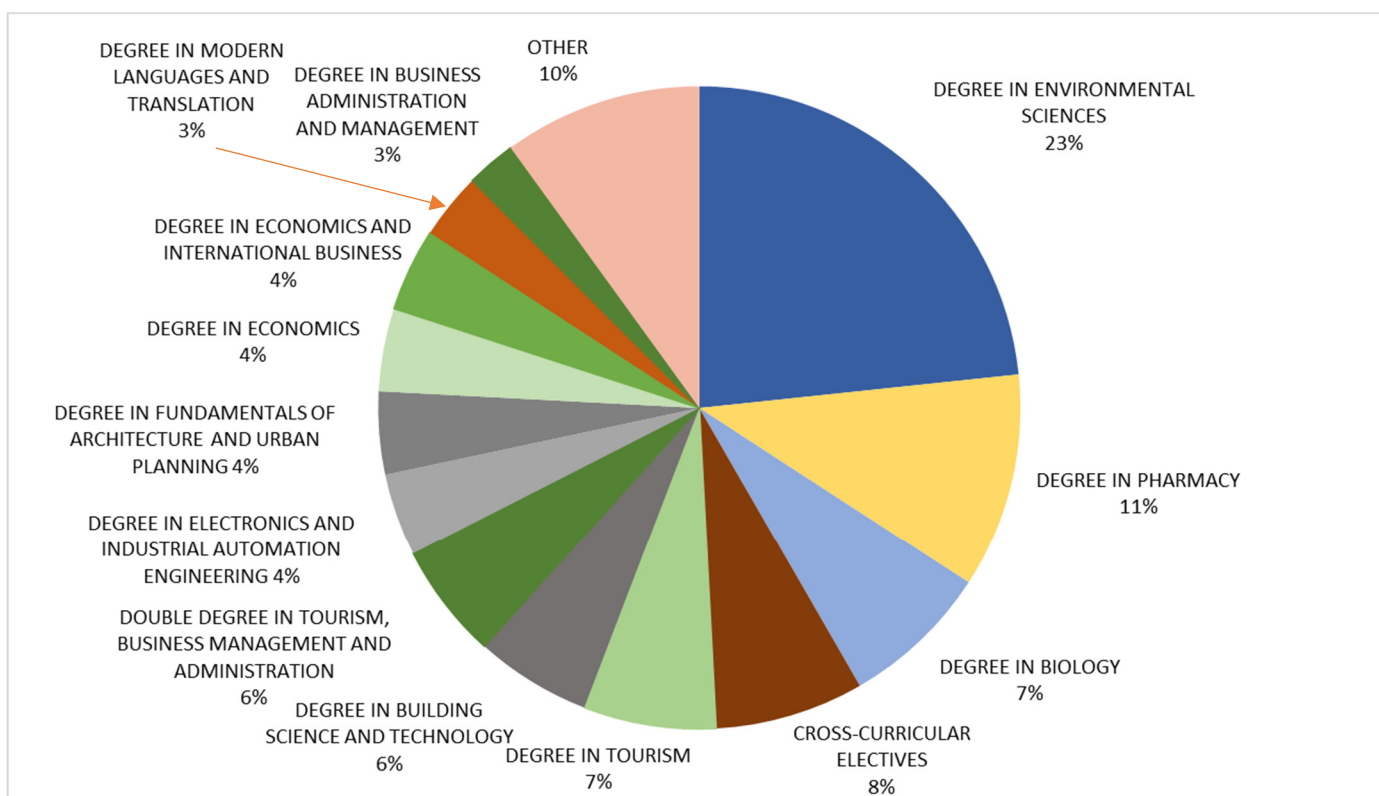


Figure 2. The distribution of courses dealing with environmental sustainability at the UAH, grouped by degrees.

The proportion of environmental contents in the different degrees of the university was quite diverse. The highest proportion was again for the Environmental Sciences degree, which included 70% of all their courses with a significant proportion of environmental contents. At long distance followed Pharmacy (25%), Building Science and Technology and Biology (both 20%), Tourism and Industrial Engineering, Tourism and Business Administration, and Architecture, with around 10%. The very low proportion of environmental contents in the degrees of Education (only one course among the 144 offered), Medicine and Nursery was noteworthy.

Comparing the number of courses offered and the proportion of those with environmental contents, the differences between knowledge areas were quite remarkable (Figure 3). Social and Law sciences had 37.4% of all courses offered at the university, but only 26.7% of the courses with environmental content. Science degrees included 6.3% of all courses offered at the University, but they had 32% of the courses with environmental content. Engineering degrees had 20.7% of the total courses and 15% of the courses with environmental content.

Finally, comparing the proportion of environmental courses within each knowledge area, we observed significant differences between the science degrees, with 28% of the courses offered having environmental contents, and only 4.6% for the health sciences or 4% for engineering studies.

Table 2 includes the most frequent environmental concepts covered by the selected courses, as a first assessment about the main topics developed in the classes. The relevance of each concept is expressed by the Concept 1 to Concept 5 tags (sorted from most to least important for that course), and the table includes the number of times that that concept was selected in the first to fifth position. This classification was done by an expert assessment of the relevance of each concept in the course syllabus. The most frequent concepts were those with a general coverage, such as AMB (generic environment content) and SOSTENB (generic sustainability), followed by those related to “Assessment of the environmental

and social impact of economic activities” (IMPCT), “All economic concepts related to the environment” (ECO) and “Use of renewable energy and energy efficiency” (EREN). Among those selected in the second rank of importance, more specific concepts were found, such as BIODV (Biodiversity), RECURNA (Natural Resources) or PROCON (Responsible production and consumption). The low proportion of courses covering environmental concepts widely covered by the media was noteworthy, such as “Climate Change” (CLIMN) or “Natural hazard prevention and mitigation”, which were quoted only by 10% and 8% of the selected courses, respectively.

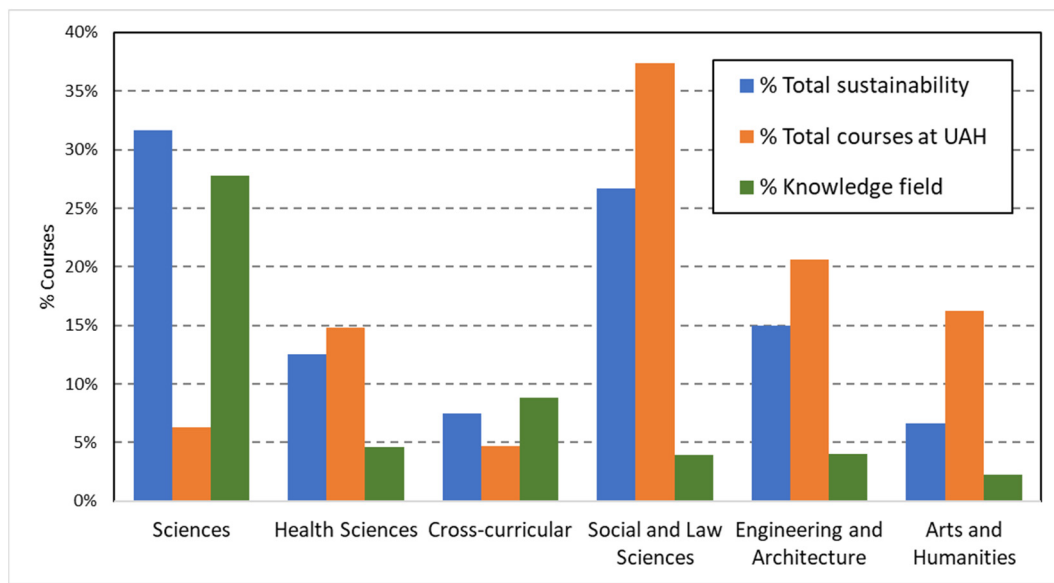


Figure 3. Distribution by knowledge fields of the courses with environmental sustainability content over the total number of these courses (green), over the total number of courses taught at UAH (orange) and over the total number of courses taught in each knowledge field (blue).

In terms of pedagogical methodologies (Figure 4), most of the selected environmental courses indicated the prevalence of seminars based on the professor’s presentation of material (81%, plus another 10% that indicated to be the second most used method). Labs and field work was the second most common method, but way behind the former with 7% indicated as the main method and 36% as the second one. The third and fourth most commonly used methods were oral presentation and in-class discussion by students. Project/problem-based and service-based learning were rarely used, in spite of being recommended by the Spanish university network as the most adequate methods for environmental education.

In addition to these general methodologies, some syllabi also included specific activities to promote the students’ self-reflection about sustainability as a way of living, for instance through the calculation of a personal carbon footprint or through experiencing water limitation for basic needs during a certain period. Other pedagogical activities included the student’s design of a public health or land management project, design of plans for waste residue handling and student’s debates about a movie or real-case dilemmas.

Finally, in terms of grading tools, most environment-oriented courses were based on written essays and exams, which were the most important evaluation instruments in 89 and 79 courses, respectively. Class participation was also considered a minor criterion, although it was part of the evaluation process in at least half of the selected courses (Table 3). It is worth mentioning here that in order to fulfil the SDG commitments, higher education institutions need to think more creatively on assessment strategies, as with written essays and exams the focus would only be in declarative knowledge.

Table 2. Distribution of courses by the environmental concepts analyzed (see Table 1), assigning Concept 1 to Concept 5 according to their relevance in the course syllabus, from most to least important.

Environmental Concept	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Total
AMB	30	12	1	1		44
BIODV	2	11	1			14
CLIMN	2	1	6			9
CNSE	1	3	3	4		11
ECO	8	1				9
EREN	8	2	4		1	15
ETAMB	2	1	1			4
GESTAM	2	3	10	3	1	19
HUMAMB	7	2	2		1	12
IMPCT	9	11	3	1	4	28
INFHU	4	7	1	1	2	15
PROAM	2	1	3	1	1	8
PROCON	2	8	3	4		17
RECURNA	3	10	2	7	2	24
REMED	2	1	2	2	3	10
RURL	1					1
SOSTENB	10	6	9	1	4	30
TECAMB	1	2	5			8
URBN	3		2	2		7
Total general	99	82	58	27	19	

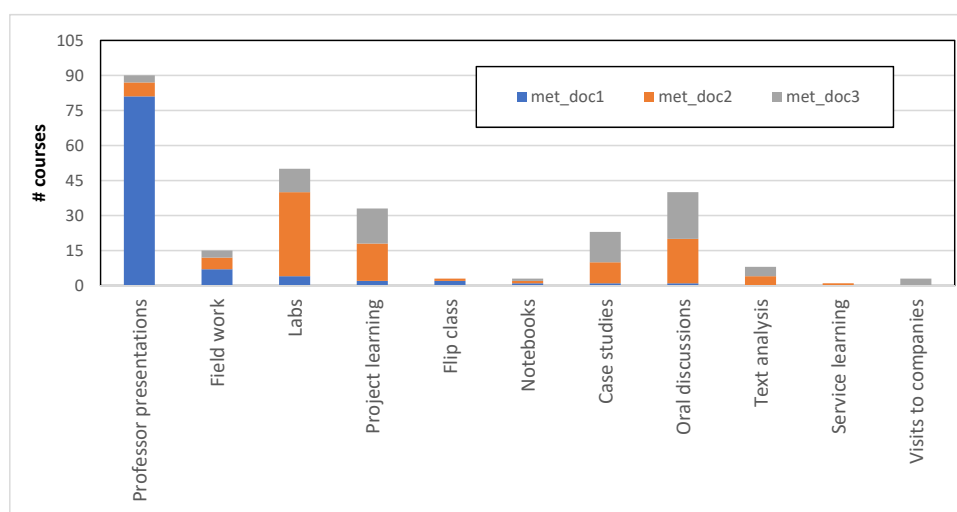


Figure 4. The distribution of methodological strategies used in the selected courses. The first three (met1, 2 and 3) were plotted according to the course syllabus. Bars indicate the number of courses that apply those teaching methodologies.

Table 3. The distribution of courses according to their evaluation methods, assigning eval1 through eval3 according to their relevance in the course syllabus, from most to least important.

Evaluation Instruments	Eval1	Eval2	Eval3	Eval4
Written exams	77	7	5	89
Oral expositions	2	19	19	40
Participation in class	1	10	36	47
Practical work	1	5	1	7
Written essays	18	52	9	79
Total	99	93	70	262

4. Discussion

The methods described in this paper could be easily applicable to other universities. They are based on objective criteria to evaluate the extent and contents of environmental instruction in a certain higher education institution. The automatic search within course syllabi based on a comprehensive list of keywords facilitates a first screening of the courses, but it needs to be complemented by manual analysis, particularly to put those keywords in perspective, avoiding double meanings of certain words. Completing the survey with a dedicated questionnaire also added value to our research. Although the survey was not massively answered, it was actually useful to solving some controversial cases. A clear example are courses of humanistic content, which do not explicitly indicate environmental content in the course guides, but they may include them in the practical work, such as when doing an ecocritical analysis.

The particular outputs of our research indicate that the University of Alcalá has still a marginal presence of environmental content in its academic offer, with only 5.5% of all courses offering significant content of nature-related concepts. Moreover, most of these courses are not mandatory (60% are optional) and therefore the level of exposition of our students to environmental education can still be qualified as minor. It is difficult to compare this assessment with those of other Spanish universities, as there are no similar studies in other colleges.

As we expected, the degrees that were more connected to environmental concepts were found in the Faculty of Sciences, hosting Environmental Science and Biology degrees. Tourism, Pharmacy and Architecture were also better-exposed to sustainable concepts. A lack of courses with environmental content in Education, Medicine and Nursery, which should be more closely linked to them, was noteworthy. Medicine and Nursery should also be concerned about the impacts of air and water pollution on human health, as well as the multifactor impact of climate change. Education degrees train the near-future teachers, and therefore the exposition of those students to environmental concepts is fundamental to spreading them to young generations. It will be difficult to promote the necessary social change to reduce the negative human impact on the environment if young students do not receive that inspiration from their teachers.

Concepts within the selected courses mainly covered general environmental questions, still with little presence of specific problems, such as climate change, biodiversity loss or rural abandonment. Teaching and evaluation methods were found quite conservative, with a high prevalence of oral seminars and written exams.

In studies such as this one, the concept of “academic freedom” should be considered. Dealing with environmental concepts should not be mandatory for all courses, but a careful selection of the adequate ones should be addressed to ensure that all students are exposed to concepts of environmental sustainability. One possible approach would be to include them at the same time in selected mandatory courses, complemented with cross-curricular ones.

It is difficult to compare the situation of our university in terms of environmental education with that in other Spanish institutions, because there are no similar studies based

on quantitative assessments of the course syllabi. However, some authors have identified obstacles and potential solutions for improving education contents in higher education, including the impact of management strategies of the university [19], while others have analyzed the presence of environmental concepts in the degree's programs [16]. The latter are closer to our work, but comparison is still complex as they cover all dimensions of sustainability (social, urban, educational), while we restricted the analysis to environmental contents. However, the degrees they identified as the most clearly implicated in environmental education were similar to ours, with Chemistry, some engineering degrees, Pharmacy and Food Science providing the highest proportion. Another study based on evaluating the competences proposed in the different degrees of the National Open University [17] also observed coincidences with our analysis, particularly the importance of Environmental Science and other Science degrees. This study is a first attempt to objectively evaluate the extent of environmental education in our university and it may be useful for other higher education institutions to compare their situation with other centers and eventually monitor their trends. We used a single academic course, which may provide a limited analysis, and plan to repeat it in the future, ideally in five-year cycles. In terms of explicative factors, our analysis is not conclusive, as it was based on a reduced survey to the university professors. However, we can point out as important constraints the lack of professor's knowledge about environmental issues and time limitations to cover the contents assigned in the programs. Similar works carried out by colleagues in other countries have evidenced, among others, as main obstacles the lack of specific training of teachers in these matters, the multidisciplinary nature of research related to sustainability, misunderstandings about the need to include these concepts, the workload of teachers and that these subjects are seen as marginal, away from what is considered essential in each degree [15]. Beyond the knowledge that teachers may acquire through environmental training programs, these types of initiatives contribute to a change in attitude, favorable to incorporating these subjects in the curriculum, contributing to environmental sustainability [21,22]. In addition, institutional aspects should also be considered, particularly the existence of long-term strategies that may link environmental management and education, with a strong liaison with university stakeholders [23]. Actually, different authors have emphasized the need to establish formal structures that may guide those strategies, instead of favoring prompt actions [5].

Doubtless, a better understanding of the obstacles will make it possible to improve current tendencies. In any case, knowing the starting point is critical to establishing long-term plans, including specific formation and incentives to incorporate environmental concepts across the disciplines. Concern, knowledge and proactive attitudes about environmental problems are essential components of a citizen's education nowadays. Universities have to be fully implicated in this task, which includes obviously extending education offer about these components, but also improving the teaching methods and making them better adapted to the change of values and attitudes required to solve the environmental crisis. An integral view of how sustainability and moral commitment should impact daily lives should also be a part of a sound university education [8].

5. Conclusions

We have presented the first inventory and analysis of environmental sustainability education in the degrees of the University of Alcalá. To do so, we have developed a methodology that can be used to standardize the evaluation of teaching in environmental sustainability at higher education institutions. The methodology was based on the combination of automatic statistical analysis of the courses' syllabi, which guided the initial selection of the relevant courses. After this process, a detailed manual revision of the selected courses was carried out, carefully analyzing their contents and their methodological and evaluation strategies.

Our analysis showed a very limited presence of environmental contents in undergraduate teaching of our university, since only 5.5% of the offered courses covered these

issues. From them, only 40% were mandatory, which further reduced the overall exposure of our students to these contents. Although some degrees had a considerable proportion of courses related to environmental sustainability, the scarce presence in others that should be closely associated with these contents was striking, particularly those of Education and Health Sciences, where Medicine or Nursing did not include any course with environmental content. We believe it is essential that all professors be aware of environmental problems and assume a greater commitment to environmental sustainability, leading the communication of these values to the rest of society. It does not mean that we are claiming that all courses should include a significant discussion of environmental sustainability concepts, but we do believe that all university students must be exposed to them in their university education. In this process, the role of the university governing boards is crucial to define medium- to long-term plans that successfully address the essential requirement of extending environmental sustainability education to all university students. We have much at stake.

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Institutional Review Board Statement: The study did not require ethical approval.

Data Availability Statement: The data generated in this study are available upon request: list of concepts and keywords, syllabus documents, list of analyzed courses, list of selected courses, statistics on keyword and concept occurrences per course. Additionally, the source code for the automatic analysis is available for interested researchers.

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

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