Abstract

Transferring sustainability concepts, like the environment, climate change and waste management, to different higher education degree programmes is a complex issue. It is a challenge to engage the different branches of engineering in this issue. Our project, called Plastic-Free Forestry School, encourages Universidad Politécnica de Madrid schools to introduce measures targeting the entire academic spectrum, ranging from students to academic faculty.

The experience is based on an initiative targeting students supervised by one or two professors specializing in the environment as part of waste management courses within the BSc in Environmental Technologies Engineering, BSc in Natural Areas and Environmental Engineering and MSc in Forest Engineering, all taught at the Universidad Politécnica de Madrid (UPM).

Eight students participated in the initiative. The methodology was based on inventories of the waste generated at UPM schools produced as a result of two final-year projects: one concerning recyclable waste (light packaging, paper and cardboard and glass) and another focusing on other waste. The pilot study focused on the School of Forest Engineering and the Natural Resources and the UPM's Main Head Office.

These projects characterized the waste over a three-year period at both facilities, focusing on the components that most affect university students’ environmental education, specifically, single-use plastics. They identified the generation points outdoors (sports grounds and arboretum) and indoors (hallways and classrooms, mainly from containers brought from home, and cafeteria and offices).

After the study, students applied a series of curricular and extra-curricular strategies to raise awareness among the higher education community about minimizing consumed plastics. The aim was to reduce plastic waste generation by 80% in one year and to zero waste in two years.

The project is divided into a number of duly publicized UPM-wide activities. They included on-campus games with plastic waste held on open areas or sports grounds to disseminate the scale of the problem. Another key activity was the preparation of a good practice manual, and the organization of seminars and talks for peers and secondary school students.

The result was very encouraging in terms of the adhesion of a sizeable number of faculty members to the initiative, support received from academic authorities, the voluntary extension of the project to other schools, and an increase in interest in environmental issues from different technological courses, demanded by the students.

Keywords: Higher education, student experiences, classroom transfer, sustainability, plastic-free university.

1 INTRODUCTION

This research was designed in response to the Universidad Politécnica de Madrid’s Sustainability Plan [1]. It is not easy to move the concepts of sustainability and dematerialization of the economy [12] into the classroom due to the wide-ranging academic disciplines taught at UPM, stretching from telecommunications to natural environment engineering. As a result, it is very difficult to introduce such cross-cutting environmental issues into degree programmes. Accordingly, key sustainability concepts, in particular, solid waste, recycling and changes of habits in the higher education community, are unevenly and incompletely taken on board.

The Environmental Innovation Group is a research group operating within the UPM. One of its aims is to promote environmental education and training activities on UPM campuses. It has gained a
tremendous amount of experience over the last eight years, being involved in the delivery of a MSc in Sustainable Waste Management, which has trained a total of 160 students, and the implementation of a number of projects for UPM schools in partnership with the private sector. Projects have focused, for example, on community waste management or the promotion and organization of waste collectors in the natural environment. The purpose of such projects is to promote educational programmes on sustainable living, sometimes in partnership with the private sector, in order to improve relations between private companies, the higher education community and local authorities [3].

Waste management technologies is a subject currently taught at the UPM as a compulsory or optional course within three degree programmes (Table 1). The implementation of the MSc in Circular Economy for the 2019-2020 academic year includes a large enough number of ECTS credits in this field for it to be regarded as a specialist waste management course.

### Table 1. Degree programmes and students who have specifically studied waste management issues at UPM

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BSc in Natural Environment Engineering</td>
<td>32</td>
<td>36</td>
<td>35</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>BSc in Environmental Technologies</td>
<td>--</td>
<td>--</td>
<td>28</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>MSc in Forestry Engineering</td>
<td>10</td>
<td>12</td>
<td>28</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>MSc in Circular Economy</td>
<td>No data. Newly established</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In December 2015, the European Commission (EC) adopted an Action Plan for the Circular Economy, citing plastics as a key priority. The EC undertook to "prepare a strategy that addresses the challenges posed by plastics throughout the entire value chain and taking into account the totality of its life cycle" [4]. In 2017, the EC confirmed that it would focus on the production and use of plastics and that it would work to ensure that all plastic containers are recyclable by 2030 [5].

Annually, some 25.8 million tonnes of plastic waste are generated in Europe, of which less than 30% are collected for recycling [6]. A significant part of this plastic waste leaves the EU to be treated in third countries, where different environmental standards may apply.

The problem is magnified by the increase in single-use plastic waste that is generated each year, that is, plastic containers or other products that are disposed of after being used only once. For example, small containers, bags, cups, lids, straws and cutlery, which are usually made of practical, lightweight, and low-cost, are not recycled and often end up littering the floor.

This is not so much a matter of a deficient disposal and collection infrastructure at UPM schools or research centres than a question of education or, alternatively, training. Environmental education should have a significant influence on environmental awareness, everyday lifestyles and consumer behaviour of the university’s student body, faculty and other staff.

This is the problem addressed in this paper by setting the objectives outlined in Section 2. The environmental education approach should to play an important role in shaping attitudes about sustainable consumption. Environmental education addressing the issue of consumerism clearly increases awareness of the need for consumption-related lifestyle changes [7].

### 2 OBJECTIVES

In this context, there have been numerous initiatives targeting the university as a whole. The most important are:

- Study of the generation of light packaging and paper/cardboard at our schools and research centres, leading to the introduction of small yellow and blue containers. The study was conducted by the Environmental Innovation Group based at the School of Forestry Engineering and Natural Resources.
- Study on zero waste at UPM, again conducted by Environmental Innovation Group, for the UPM’s Main Head Office and the School of Forestry Engineering and Natural Resources.
Based on the above studies, we collected data and identified needs or opportunities for proper waste management. This led to the design of this new Plastic-Free Forestry School initiative.

The slogan devised by the School of Forestry Engineering and Natural Resources for the challenge was *We can do it*.

Plastic-Free Forestry School follows on from the Protected Natural Areas and Urban and Peri-Urban Forests experience as a means of improving the population’s quality of life and protecting the environment. Our faculty, administrative and service staff and student body should act as ambassadors for reducing plastics in society, as a result of this classroom-based and collaborative training initiative.

Therefore, the targets set as new challenges were as follows:

   a) Eliminate single-use plastics at the School of Forestry Engineering and Natural Resources
   b) Launch campaigns to raise the awareness of all members of the educational community with respect to the 3Rs (reduce, reuse recycle), providing related guidelines and organizing events
   c) Extend the *Save plastics, save the world* concept to primary and secondary schools through our students
   d) Address the zero waste principle by extending the initiative to other materials.

3 METHODOLOGY

The research reported here is based on studies carried out three years ago by third-year undergraduate students and staff from the School of Forestry Engineering and Natural Resources at UPM.

3.1 Promoter group

The promoter group was composed of student volunteers (six women and three men) and two faculty members (one male and one female). They designed the Plastic-Free Forestry School initiative. As it was voluntary, the project member workload varied, amounting on average to about three hours/week for faculty and about six hours/week for students. The project work team members were stable, although plans for their replacement with new students are afoot, as the current members are now scheduled to complete their degree programmes.

3.2 Starting data

The initial data are important, as three clear hot spots were identified within the facilities:

   - Areas around and outside cafeterias
   - Areas around libraries
   - Sports grounds.

As a result of two final-year projects that used standardized methodologies [8] to conduct studies to characterize waste production at UPM over a three-year period, we estimated that 1,380 kg light packaging was generated per year. It was composed of 814 kg of plastic containers and about 76 kg of plastic products other than packaging (with total plastics accounting for 890 kg/year). The distribution (wet weight) was as follows:

   - Polyethylene terephthalate (PET): 35% (water and soft drinks bottles)
   - High density polyethylene (HDPE): 15% (rubbish bags, cleaning products containers, food boxes, etc.)
   - Polyvinylchloride (PVC): 1% (irrigation pipes and water pipes, wiring, etc., whose source was building works)
   - Low density polyethylene (LDPE): 30% (plastic bags and wrappers)
   - Polystyrene (PS): 10% (plastic cups, cutlery, plates, and other catering industry wastes)
   - Miscellaneous: 9% (unsorted plastics and Styrofoam).

These figures will constitute the benchmark for monitoring plastic waste reduction targets at the listed facilities.
3.3 Activity Design

With the aim of engaging the entire educational community at the School of Forestry Engineering and Natural Resources in the project, several activities were carried out to launch the initiative.

a) Challenge recording (VR)

Faculty, administrative staff and students recorded a video for the “We can do it” challenge to be uploaded to a YouTube channel.

b) Skittles with plastic bottles (SG)

A game of skittles was organized in partnership with the Global Challenge NGO in late November 2018. Everybody that entered the School of Forestry Engineering and Natural Resources on the specified date was given a plastic container which he or she had to throw against other containers set up as skittles. The idea was that the pile on the floor at the end of the morning should draw attention to just how many containers and bottles we consume in a single morning.

c) Initiative presentation (IP)

From December 11 to 18, 2018, the initiative was presented to the entire school. A short talk was held to introduce the initiative and explain what we expected to achieve. We asked the educational community at the School of Forestry Engineering and Natural Resources for support, and the initiative was publicized externally through social networks. Posters announcing the presentation were designed and posted on social networks with the support of the student union.

d) Miscellaneous activities (MA)

- Cyclically: plastic bottle top collection; waste recycling points ... (MA1).
- Forest Week: Participation in the Forest Week Programme on March 20 or 21, including:
  - Recycling (upcycling) workshops (MA2)
  - Plastic Engulfs You plastic bag protest, where a large inflatable plastic bag was devised for people to get inside and be photographed (MA3)
  - Sale of Plastic-Free Forestry School products at an outdoor stand, and design of good practice manual (including photos or drawings) for distribution (MA3)
  - Panel discussion on Is Plastic Swallowing Us or Are We Swallowing Plastic? Solutions (PD).
- Forest cleanups, with scheduled dates, activities and signup system. (FC) According to published studies [9], participation in environmental education is a robust tool for forging relationships between university and secondary school students with an increase in the feeling of being connected with nature and its conservation in the short term.
- Production of a good practice manual (GP).
- Signing of agreements and alliances with other institutions to support the extension of the initiative and experience to primary and secondary school students in Madrid (AS).

4 RESULTS AND ANALYSIS

The results have not been evaluated until this year. The above activities are shown in Table 2, specifying the participation of the educational community at the School of Forestry Engineering and Natural Resources with respect to a total of 120 faculty; 950 students and 56 administrative and service staff.

The student members of the promoter group have established contacts and managed the signature of collaborative agreements with respect to:

- Plastic caps: all bottle tops collected are donated to a NGO raising money to combat rare diseases
- Forest cleanups: an agreement with a large number of schools was signed
- Environmental education: the agreements have been limited to date to one student residence.
Table 2. 2018-2019 activities and ongoing community engagement

<table>
<thead>
<tr>
<th>Activities</th>
<th>Number of participants / attendees</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Faculty</td>
<td>Admin</td>
</tr>
<tr>
<td>VR</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SG</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>IP</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>MA1</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>MA2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>MA3</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>MA4</td>
<td>66</td>
<td>18</td>
</tr>
<tr>
<td>PD</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FC</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>GP</td>
<td>65</td>
<td>34</td>
</tr>
<tr>
<td>AS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As Table 2 shows, faculty and administration and services staff engagement is generally poor, whereas student body involvement is high bearing in mind that class attendance for the respective degree programmes is, on average, 65% of the total student body (about 600 students).

Prevention-based waste reduction has been estimated with respect to the initial baseline (Table 3). These activities have led to a 63.45% reduction of single-use plastics by weight, where the primary target was plastic soft drinks and bottled water products and plastic catering disposables like cups, cutlery, and plates. Plastic bag reduction has been encouraged by European legislation in this regard.

Table 3. Percentage plastic reduction at the School of Forestry Engineering and Natural Resources

<table>
<thead>
<tr>
<th>Plastic Type</th>
<th>% baseline figure</th>
<th>% decrease</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>PET</td>
<td>35</td>
<td>68</td>
<td>They are no longer used at official events</td>
</tr>
<tr>
<td>HDPE</td>
<td>15</td>
<td>5</td>
<td>This is the cleaning service’s responsibility</td>
</tr>
<tr>
<td>PVC</td>
<td>1</td>
<td>0</td>
<td>There have been no building works</td>
</tr>
<tr>
<td>LDPE</td>
<td>30</td>
<td>95</td>
<td>Awareness raising was aided by legislation</td>
</tr>
<tr>
<td>PS</td>
<td>10</td>
<td>95</td>
<td>Replacement by cardboard in coffee shops</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>9</td>
<td>10</td>
<td>From purchases and supplies</td>
</tr>
</tbody>
</table>

5 CONCLUSIONS

The experience has been satisfactory. It is translatable to the entire university and serves as an example to society. The adoption of the project in other non-environment-related degree programmes will help to raise the awareness of faculty and students who will act as ambassadors of environmental responsibility within non-university environments.

This first-year experience has also shown that there is room for improvement with respect to faculty and administrative and service staff engagement. They are members of the educational community in positions of responsibility with respect to teaching and research, which may, to some extent, account for the low level of participation. Activities should be designed in the future to engage these groups.
We have shown that it is possible to reduce single-use plastics consumption. This requires collaboration on the part of waste generators, in particular, equipment and catering suppliers. This would be possible if the contract specifications explicitly referred to the use of non-plastic packaging.

It is possible and necessary to adopt these consumption guidelines in everyday university life in order to avoid plastic waste. The experience can and should be transferred to schools. School students play a key role with respect to a plastic-free university and plastic-free education.

REFERENCES


