SERVICE-LEARNING EXPERIENCE THROUGH OUTREACH AND ENGAGEMENT WITH SCIENCE AND TECHNOLOGY MUSEUMS

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ABSTRACT

The paper describes and analyzes the service-learning experiences of various engineering students in two science and technology museums, over the years 2020, 2021 and 2022. The experience was based on the design and implementation of education and outreach activities and scaffolding material was provided.

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Student learning was significant not only in terms of content but also in terms of generic and transversal competencies. In addition, this service-learning model shows a good potential to address some of the problems in engineering today, such as the declining interest in engineering among school students. Thus, it can be a win-win model for all the agents involved: museums, university, the student himself and society in general.

1 INTRODUCTION

This paper aims to analyze some effects of engineering students' experiences in science and technology museums, within the framework of service-learning, as the kernel of a study on improvement of teaching and innovation.

This section first describes what is meant by service learning and how it is applied in the field of engineering. On the other hand, we place the reader in the context of this experience with a brief description of the agents involved, museums and the Manresa School of Engineering and their relationship with each other. The second section includes a brief description of the activities carried out by the students, the relationship with other service-learning experiences and the goals and methodology of our study. The results are presented in the third section followed by brief conclusions.

1.1 Preliminars on Service-learning in engineering

Last decades, service-learning has been considered in higher education as an active learning strategy to be applied to many areas consistent with the change of paradigm in education from a focus on teaching to a focus on learning. It is a pedagogy integrating academic learning with community-based work, with a two-fold focus: learning for the student and service to the community. It can be defined as “a form of experiential education in which students engage in activities that address human and community needs together with structured opportunities intentionally designed to promote student learning and development. Reciprocity and reflection are key concepts of service-learning” [1].

Engineering has a vast potential for service learning, and several models of engineering service learning have been presented in the literature, discussing the benefits and outcomes of the program. A well known program is Engineering Projects in Community Service (https://engineering.purdue.edu/EPICS), EPICS program, initiated at Purdue University in 1995. It is described by Kirsch [2]: “(it) empowers students to work with local service organizations to apply technical knowledge to implement solutions for a community’s unique challenges. In this way, EPICS in IEEE not only assists communities in achieving their specific local improvement goals but also encourages students to pursue engineering for community improvement as a career.

1.2 The Museum of Geology, a university museum

The Museum of Geology "Valentí Masachs" was founded in 1980 by Dr. Valentí Masachs. It was started with his private collection of fossils and minerals as well as collections from other founding members of the museum. In 1993 showcases of mineral applications were added.

The museum is part of the Universitat Politècnica de Catalunya (UPC), and it is therefore a university museum, like other museums around the world. It is located on the UPC campus in Manresa, connected to the classrooms and laboratories, and it is strongly linked to the university in its day-to-day research and teaching. It also serves students and teaching staff from all levels of education and it is a channel of connection between the university and the education system. The museum is also open to the general public.

The museum collection increased over the years thanks to the work of its directors, faculty and students who contributed to it through their research. At present, the museum has a collection of about 5000 minerals, 2000 rocks and 3000 fossils.

1.3 The Manresa Technical Museum

The Technical Museum of Manresa is located in the old water tanks of the city, with a capacity of 12,000 m³ of water. The museum was founded in 1993 on the initiative of the municipal company "Aigües de Manresa SA", Manresa City Council and the Museum of Science and Technology of Catalonia. Since 1992 it is part of the Science and Technology Museum System of Catalonia, and since 26 November 2004, it has been integrated into the Manresa Science Heritage Park. The Museum is also part of XATIC, the "Xarxa de Turisme Industrial de Catalunya" and the Water Museums Global Network.

1.4 The UPC Manresa School of Engineering

The Universitat Politècnica de Catalunya (UPC) is a public institution of research and higher education in the fields of engineering, architecture, sciences and technology. It is one of the leading technical universities in Europe with a widespread presence in Catalonia, through nine campuses. Manresa School of Engineering is the campus located in the city of Manresa, offering several Bachelor's and Master's degrees. The list of Bachelor's degrees covers several fields, namely Industrial Electronics and Automatic Control Engineering, Mechanical Engineering, Chemical Engineering, ICT Systems Engineering, Mineral Resource Engineering and Mineral Recycling. Students can also enroll in Master's degree in Natural Resources Engineering, Master's degree in Mining Engineering, Master's degree in Mining Engineering and Master's degree in Geotechnical Engineering, all of them very related to the Museum of Geology referred above.

2 ACTIVITIES IN THE FRAMEWORK OF SERVICE-LEARNING

2.1 Brief description of the activities

Both museums, the Museum Valentí Masachs and the Technical Museum of Manresa receive a large number of visits from primary and secondary school students throughout the academic year. Students enrolled in engineering degrees are encouraged to guide the visits and give workshops. The variety of degrees taught at EPSEM allows museums to match activities and students taking into account students' profiles. The experience is based on the design and implementation of education and outreach activities. Learning materials were provided. Training sessions are conducted by faculty to enforce students' knowledge and students' skills, in order to ensure learning for the student, and the quality of the service. Design and creation of new workshops is a challenge for the students too.

Actually, specialized training sessions have been designed, putting together sessions by leisure professionals and experts in museography and technology, face-to-face sessions in the two museums, and practical sessions in exhibition activities. Two editions have been implemented. It is worth mentioning that these were highly valued by the participants. There were no known structured descriptions of recommended training to support students to develop this kind of activity. Thus, the design, program and the two editions experience can be of interest.

Some final undergraduate and master's degree projects (TFE, in Catalan) are also related to the two museums. Thus research, development of theoretical frameworks and creation of manipulative material such as prototypes are carried out by engineering students under the supervision of several professors.

Students are also involved in collaboration projects of the museums with secondary schools with special needs. For instance, some students collaborated with the secondary school IES Guillem Catà, through the Museum Valentí Masachs to design and equip a small museum of mineralogy in the school to enable hands-on and active learning. In addition, the students participate in cooperation and development projects at the international level, mostly related to sustainability and social projects, one of the main areas of dissemination of the Museum of Geology Valentí Masachs. They are also involved in some cases of TFE.

In the context of this article, research was conducted for information on similar experiences. Most of the known examples of service-learning in engineering correspond to the model of project design, or the model of development and cooperation in another placement, International or not, which should not be confused with International volunteering or internships.

But some examples similar to our activity can be also found. A course where college students work with elementary school students is studied in [3], including a description of lessons learned and best practices. In [4], projects for 35 different undergraduate core courses are summarized, including for example the design and construction of

displays to illustrate various technologies for middle school students. Several features are studied there in the context of USA universities. This paper wants to contribute to the study of some particular features in our context, in order to develop a further study in engineering service-learning experiences in universities in Catalonia.

2.2 Setting the goals of the study and the methodology

In this paper, the goal is to survey students' perceptions of their learning, referred to content and competencies, show connections to particular subjects, and collect data on the impact of academic and social projection of students through Science and Technology museums.

The main focus will be the generic competencies in UPC undergraduate curricula, cf. [5]. Our main hypothesis is that this service-learning experience has a positive impact on the achievement of competencies. It is a student-centered study, so the survey instrument is designed to be answered by students. Besides the students' perception of competencies achievement, it is intended to measure the influence of service-learning activities on students' perspectives about engineering, their career interests, and social consciousness.

The methodology consists of: (a) the careful design of a questionnaire, with valid and reliable questions, including a test and a revision; (b) the distribution of it to the population we are interested in, namely students who have been involved in outreach activities in museums; (c) data cleaning analysis, and interpretation, (d) completion of the survey with some personal interviews.

The questionnaire combines open-ended and closed-ended questions, in order to get both qualitative and quantitative responses. It is structured in several parts. The first part collects the data prior to the museum's activity. The second part collects quantifiable information on the name of the workshops in which the activity was carried out, the school year, the amount of schoolchildren involved, etc. The third part takes care of the relation with academic subjects related with the activities. The fourth part focus on their perception of improvements in general competencies. The fifth part collects the personal and professional impact. Finally, the last one reflects on the social commitment of the university and its relationship with STEAM. See figure 1.

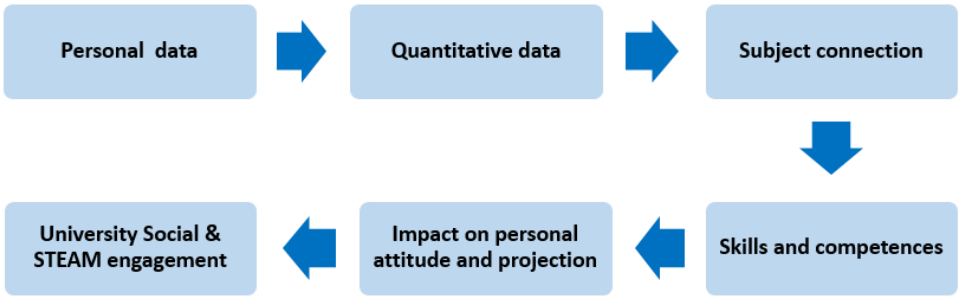

Fig. 1 . Structured parts of the questionnaire

The questionnaire can evolve to be used as a tool to encourage students to reflect on learning, a very important step to make meaning of the experience, cf. [6]. Open-ended questions and interviews can be used for further refinement of the form.

3 RESULTS

The questionnaire was distributed to students who have been involved in outreach activities in museums. After getting the responses, data cleaning allowed us to identify and remove responses from people who either didn't match our target audience (not students, or involved in museums not related to science and technology). Final sample included ten students, six males and four females, from four different engineering degrees, who participated in outreach activities in one of the two museums, related with their degree. We will denote them S1, S2, ... S10, following the order of seniority of participation, from February 2016 to the present.

Information was completed with three personal interviews: (S3) a master's student enrolled in the museum program two years ago, who is still collaborating; (S10) an undergraduate student, currently enrolled in the museum program; (S9) a former student enrolled in the program who is nowadays a teacher at secondary school.

Students responses to the questionnaire confirmed impact on subjects learning, even after finishing them. Connections with several subjects (at least three each) were stated. They admited to change their opinion about some subject value (increasing it) and discovered some contents that they have overlooked and decided to review to be more confident about, and they were more interested in the course they were studyng at the time the activity at museum was developed. For example the question: "Did the questions the students ask you and the chance to explain them some answers increase your learning?" got a 70% of the answer "yes quite often".

In terms of competencies, as expected, "Efficient oral and written communication" is the one that students are most aware of having improved with the experience in the museum. S10 states explicitly in two occasions: "explain concepts that you already know are very beneficial. It allows you to improve your skills to express concepts clearly and concisely", or "I have learned to better communicate my ideas, capture the attention of the audience, when explaining concepts, the way you do it, etc.".

But there are also other competencies that, from the student's point of view, have improved thanks to the museum activity, namely: Entrepreneurship and innovation, Sustainability and social commitment, and even Gender perspective. Figure 2 shows the comparison of results of the value given to the development of four generic competencies, derived from the regular subjects courses or from the service-learning experience. For the other competencies, there were no significant differences.

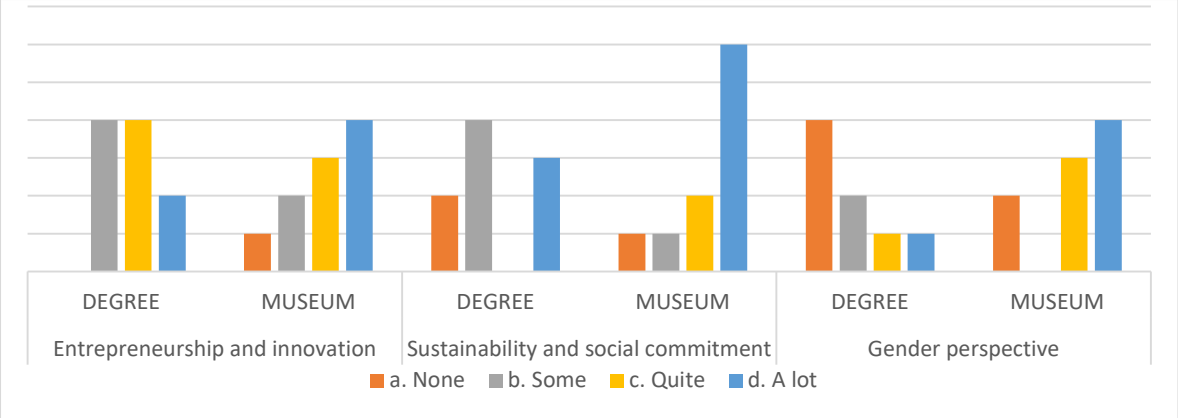

Fig. 2. Student's perception of competencies development derived from the subjects course or the service-learning experience.

As for the impact on their personal career, a clear example is S9, who says, "Literally, my job at the museum helped me find a career and ended up being the determining factor for what I now have a job that I love."

Open-ended questions revealed some ignorance about service-learning label for experiences, with the exception of some development cooperation projects, with a learning scheme. It is not clear how these experiences are offered to students, as in some cases they are only linked to optional subjects or final degree o master projects. Regarding the interest of students in these activities, a paradox similar to that cited in [7] is observed. Some students had taken part in voluntary activities related to the leisure of young children and teenagers or had taken part as a child (of course without an explicit relationship with science and technology). For them, the discovery was that they could relate it to STEAM and, in particular, to what they were studying. But the majority were students who had not been involved in such activities before. For them, the discovery has been twofold, and their learning has opened up new opportunities for them. More specifically, it has been crucial for S9, which is currently a high school teacher, and for S3, which is now targeting it.

While the activity may be more interesting to students who are familiar with the world of leisure, they often develop this facet in communities not related to university campus and do not spend time looking for such opportunities in connection with university degrees. On the other hand, students who did not participate in this type of experience confess that they discovered it thanks to the teachers who proposed it to them. It is therefore important to study the role of the teacher as well in terms of the extension of social engagement.

The interaction between students and faculty is very important for the evolution of service-learning proposals. On small campuses, such as the Manresa School of Engineering, formal and informal communication can be very helpful to significantly improve their development and analysis.

After the experience, students are much more aware of the importance of spreading their interest in engineering. They can be good STEAM ambassadors, closer to teenagers and children. Thus, apart from the win-win of student learning and the service to museums and schoolchildren, it is the whole society that will indirectly benefit.

Finally, it would be interesting to test if there is a significant positive relationship between engagement in outreach service-learning and a reduced likelihood of dropout, in the same direction as several studies on the significant positive relationship between engagement in extracurricular activities and dropout in high school (cf. [8]).

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REFERENCES

[1] Duffy, J., & Tsang, E., & Lord, S. M. (2000), *Service Learning In Engineering: What, Why, And How?* Paper presented at 2000 Annual Conference, St. Louis, Missouri. 10.18260/1-2--8694

[2] Kirsch, N. K. (2018), Service Learning in Engineering Educations, *IEEE Pervasive Computing*, Vol. 120, No. 6, pp. 1718-1731.

[3] Lima, M. (2014) The LSU Community Playground Project: Reflections on 16 years of an Engineering Service-Learning Program. International Journal for Service Learning in Engineering, Special editions, pp. 492-507.

[4] Duffy, J. et al (2008), Service-Learning Projects in Core Undergraduate Engineering Courses, International Journal for Service Learning in Engineering, Vol 3. No 2, pp. 18-41.

[5] Summary of the generic competencies and their development in UPC undergraduate curricula (2008). Institut de Ciencies de l'Educació, UPC. https://www.ice.upc.edu/ca/innovacio-docent/publicacions_ice/arxius/resum_competencies_eng.pdf

[6] Bringle, R. Hatcher, J. A. (1999). Reflection in Service-Learning: Making meaning of Experience, Educational Horizons, pp. 179-185.

[7] Bringle, R. Hatcher, J. A. (1996). Implementing Service-Learning in Higher Education, Journal of Higher Education, Vol. 67, No 2.

[8] Neely, S.R., Vaquerea, E. (2017) Making It Count: Breadth and Intensity of Extracurricular Engagement and High School Dropout. *Sociological Perspectives*, vol 60, No 6, pp. 1039-1062.