

## **SERVICE-LEARNING IN CIVIL ENGINEERING EDUCATION: NEW EXPERIENCE IN THE FIELD OF ROAD SAFETY**

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**Abstract.** Service-learning is an educational experience in which students participate in an organized service activity that meets identified community needs and reflect on the service activity in such a way as to gain further understanding of the course content and enhanced sense of civic responsibility. This new methodology has the potential to address many of the issues facing civil engineering education: can clearly enhance classroom learning, promote project based curricula and increase students' retention of knowledge. Despite the numerous benefits of service-learning in civil engineering education, little research has been done to date to evaluate this new pedagogy; and until now, literature is focused on the limited experiences of Engineers without Borders, organizations which promote and facilitate the integration of international service projects into local engineering curricula.

In terms of road safety, the prevention tools and the management of the traffic accidents is a discipline that can be better understood through the road victims' associations. Working with victims' associations can help to better understand the accident risk indicators, the types of injuries caused by these accidents and their physical and legal consequences. This paper contributes to this limited literature by assessing the positive and negative experiences encountered by students when undertaking a service-learning project for the first time. The methodology was tested on a survey sample of 61 students enrolled in the "Traffic Management" module in the Civil Engineering Master's degree at the Technical University of Madrid (UPM). Students were organized in groups of 6 and 7 members and each group was assigned with a road accident victims' association in order to develop a case study during four weeks. This pilot experience has been supported by Spain's Directorate General of Traffic (Dirección General de Tráfico) and by UPM, as part of the 2016-2017 Competitive Funding Programme for Educational Innovation Projects (IE1617-0401).

### **1 SERVICE-LEARNING IN HIGHER EDUCATION**

In 1996, Bringle and Hatcher [1] defined *Service-Learning* (SL) as a "credit-bearing educational experience in which students participate in an organized service activity and reflect on the service activity in such a way as to gain further understanding of course content

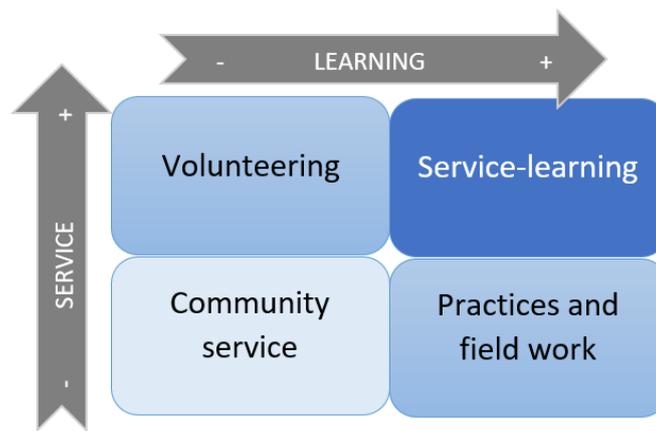
and an enhanced sense of civic responsibility". This definition is quite complete because stresses the focus on the course content and not only on the voluntary service. From a programmatic perspective there are two salient means through which universities support voluntary service: (a) extracurricular and (b) curricular. Extracurricular community service through student organizations has a long tradition, especially in the US. In American Universities is very common that many faculty, staff, and students are involved in their communities (for example, churches, neighborhood development or youth work) with independence from university courses.

Figure 1 (based on the quadrants defined by the Service-Learning 2000 Center, 1996) shows how, unlike extracurricular voluntary service, service-learning is an experience in which service activities have to be quite related to course material. Service-learning is not only community work or even a volunteering activity; the learning process has to be linked to the contents of a course. Reflection activities as directed writings, small group discussions, and class presentations usually help to adapt the service works to the course contents. As a consequence, we can identify four key components of service-learning: the service component, the academic component, the partnerships with community organizations or members (which provide the scenario and structure for the service component), and the student analysis and reflection.

Many authors [2, 3] have demonstrated the benefits of this methodology for students, teachers and community members, improving the teaching process, the academic involvement and motivation. Kuh [4] even identifies Service-Learning as one of the ten best teaching methodologies in the United States, a country where this methodology was first developed and with many examples of implementation. There are authors that find a close relationship between the employability success of the student and the service-learning experience [5] as SL provides a real life context in which students practice what they learn [6].

In relation to the type of courses suitable for the service-learning methodology, we can traditionally find many examples of implementation in degrees associated to Social Sciences and Health Sciences (medicine or nursery). Sotelino et al [5] have observed that teachers from the fields of Legal and Social Sciences are more prone to regard civic and ethical training in university as a means to the labour insertion of students but there are also isolated study cases in experimental Education like Engineering. Oakes [7] has grouped all the US Engineering experiences in an interesting Resource Guidebook where Civil Engineering is also mentioned. Although service-learning in engineering is a relatively new area of endeavor, many successful examples exist, including two pioneering models: Engineering Projects in Community Service (EPICS) and Engineers without Borders (and partner organization Engineers without Frontiers). EPICS brings multidisciplinary undergraduate design teams into long-term partnerships with local community organizations and agencies while Engineers without Borders (and partner organization Engineers without Frontiers) promotes and facilitates the integration of international service projects into local engineering curricula. These two models are not associated to any course in particular and most of the times constitute an extra-curricular activity. In relation to Civil Engineering, there are few experiences linked to road traffic engineering, but not directly to road safety. We can find an

isolated example in the University of Utah (Civil and Environmental Engineering) in a Traffic Engineering course where the Goals are to introduce the theoretical concepts that underpin traffic engineering and to apply these ideas to a series of practical traffic engineering problems. The service-learning project will address real traffic problems in real communities and relate to the practical application of the theory provided formally in class, providing service interactions in the community. Student will present reports to the community and the local groups will assess the student contributions. This learning experience is directly linked to Public participation processes of transportation plans. Public Participation has long been established for laws, regulations, and guidance issued by government agencies in the developed countries. The practice is intended to increase the efficiency and productivity of transportation plans and programs.



**Figure 1:** Service-Learning Quadrants (Service-Learning 2000 Center, 1996)

Once we have clarified the concept of service-learning and the existence of referenced experiences, the methodology used to assess this learning strategy is also very important. Surveys on student perception seems to be the suitable tool to assess service-learning experiences although there is not a specific survey format accepted by the scientific community because minimal research has investigated student perceptions of their service-learning experiences [8]. Toncar et al [9] were the first to develop a scale to measure student perceptions of service-learning experiences. Known as the SELEB scale (SErvice LEarning Benefit scale), the instrument contains items that quantify four underlying experiential dimensions—practical skills, interpersonal skills, personal responsibility, and citizenship. Some years later, Werder and Strand [10], assessed the effectiveness of service-learning in the field of education of Public Relations by measuring perceived student learning outcomes through a survey. The survey included, for example, measures of practical skills, interpersonal skills, personal responsibility, and citizenship, as well as discipline-specific functional, creative, and research skills. A similar survey was designed by Berasategui et al [11], in order to assess an experience of service-learning within the university Degree in Social Education at the University of the Basque Country. The questionnaire sought the opinion of the students about the teachers carrying out the service-learning experience and results provided positive evidences about the impact this learning process has had over the students, mainly in aspects

such as involvement, motivation and reflexive attitude.

The study of the evolution of the student curriculums through the Master degree is another alternative to surveys in order to assess the service-learning experience. Packard et al [12], for instance used multiple regression analysis applying generalized estimating equations to assess for relationships between pre and post score changes in Medicine students curriculum. This last methodology requires a considerable sample size and requires implementing the same service-learning experience during successive academic years. Due to the fact that in most Universities this experience is relatively new, databases do not allow yet to use this tool properly while surveys on perception could be a solution for the first years of implementation. Many authors have recognized [13, 14, 15] that surveys of opinion done with university students about the quality of higher education, are valid and reliable methods to obtain results related to a self-perception of the students about their own teaching-learning process. These surveys can represent an opportunity (as feedback) for the professors to re-orientate their teaching methodology [15].

Next section describes the case study used in this research focused on a pilot SL experience on road safety in higher education (School of Civil Engineering of the UPM-Spain). Surveys on student perception, based on the SELEB scale criteria, have been the tool to assess the first year of the service-learning implementation.

## **2 THE CASE STUDY: SERVICE-LEARNING ON ROAD SAFETY**

As mentioned before, there are not many experiences of service-learning on road safety in higher education but there are examples of how public participation [16, 17] has demonstrated to promote the “sharing responsibility concept” in this scenario. Kowtanapanich et al [16] show how a public participation approach can be used to assist in identifying black spot locations through the framework of an Accident Public Participation Program in Khon Kaen City, Thailand. Road safety is directly linked to the social welfare, as the reduction of the number of severe accidents and the feeling of insecurity increase the level of welfare. Students of a course on road safety could work in the future as professionals of the road safety sector, but they are also drivers and pedestrians and, under this approach, responsibilities should be shared between all of the players involved in the road safety system (Administration and users) to reach the optimum goal. Other than the acceptance and support by the community, service-learning (like public participation) can create much awareness and more concern on road safety throughout the society. After this type of experience, students will regard their rights and obligations in the traffic safety and not only consider road accidents as a problem of driver’s behavior but realize as a complex problem that can be solved.

Road safety is usually linked to the studies of traffic engineering, a subject traditionally taught at the Civil Engineering degrees. Nowadays, the complete civil engineering education community in Spain has been involved in a strenuous debate in order to determine the skills (competences) necessary for the practice of current and future engineering. The new Europe-

wide system of comparable degrees to increase student mobility (European Higher Educational Area) has been an important inducement to review university degrees and identify basic, transversal and professional skills. Moreover, engineering education has been undergoing changes promoted by the Accreditation Board of Engineering and Technology [18, 19] and corporations that hire engineering graduates. EC 2000 Criterion 3 [19] stipulates that engineering programs must demonstrate that their graduates have, among other an understanding of professional and ethical responsibility, and the methodology of service-learning has demonstrated to provide a natural opportunity for students to examine the professional and ethical responsibilities of their profession. Civil Engineering is an university degree where service-learning has always been associated to infrastructure projects in developing countries, but rarely to road safety.

In recent years, the Civil Engineering School at the Technical University of Madrid (UPM-Universidad Politécnica de Madrid) has been under a transition from the outdated degree (a six-year course) to the new Graduate and Master's degrees and the design of new courses, like "Traffic management", have represented an opportunity to implement new teaching methodologies and service-learning is one of these examples. Traffic management is an optional course (subject or module) in the fourth and last semester of the Civil Engineering Master's degree and it's taught by staff from the Department of Transport and Urban Planning. The degree is organized in four semesters (120 ECTS) and entitles the holder of this qualification to work as a Civil Engineer. After the experience of two academic years, the course "Traffic Management" has been provided with a service-learning activity and nine different Road Victims' Associations have been selected to work with students. In one semester, students are supposed to learn how to manage road traffic and all those aspects related to road safety. The subject is divided into five parts that will help students to become familiar with laws and road policies applicable to road management, the existence of different types of accidents, the risk factors influencing crash involvement and finally the best practices and the intervention tools.

The preparation of the experience, from the teaching point of view, required significant efforts in terms of time dedication and followed the following stages:

- a) Searching bibliography about experiences carried out in similar context (service-learning)
- b) Diagnosis of the type of organizations, which are object of intervention (Road victims' Associations)
- c) Selection of a group of organizations to work with the students (9 Associations)
- d) Designing a socio-educational intervention (problem definition)
- e) Implementation of this socio-educational intervention among these organizations
- f) Evaluation of the socio-educational intervention.

Once the group of organizations (road victims' Association) has been selected, students will apply the knowledge acquired to a real case, collaborating for a month with them. They must know firsthand the work developed by the different associations and contribute to propose improvement measures in the different activities that each association carries out. The main goal of service-learning methodology is to develop the students' competences compiled

within curricula, through a design and start-up of a socio-educational intervention for road accident victims that should also consider the necessities contemplated by those organizations. The case study goes from the incorporation of the students' in the daily life of the Associations to the understanding of the activities' organization, management and funding. The problem definition of the case study is shown in Table 1.

Teamwork on Victim's Associations is combined with conventional classes and, using the content of these lessons, the project work is organized in four weeks. The groups comprise six or seven members, and the project work is based on the realization of a practical case study on a Road Victims' Association. All the groups were selected according to the teacher's criteria and all of them work on the same project work. The only distinction between groups was that each group was assigned one different Victims' Association, which will allow a great variety of solutions and proposals. Each group has a team leader (selected by the lecturer), who has the task of coordinating all the members of the group and who at the same time is the spokesperson. The rest of the group members have as their main tasks the composition of the final report and the final presentation. By doing this distribution of responsibilities, not only the students' social skills are being developed, but also their teamwork abilities. The project work is carried out outside the classroom during the assigned timetable (four weeks). The teaching staff tracks the group progress through coordination meetings, answering queries and contacting the Associations when necessary. At the end of the workshop each team hands in a written report with the results of the case study to the teaching staff and two weeks later, all the groups present orally their project work in order to share their experience with the rest of the students. This service-learning activity, from the student assessment perspective, accounts for 30% of the final mark of the course, and the other 60% of the assessment carried out with a continuous evaluation based on periodic contents comprehension controls.

According to the Spanish Directorate General of Traffic (DGT), there are more than twenty-eight road victims' Associations constituted in Spain. Moreover, some of this Associations proceed as Federations. Hence, they are formed by smaller organizations with fewer resources and only exceptionally Spanish Associations are members of the FEVR (European Federation of Road Traffic Victims). The founders of the Associations use to be road traffic victims. One of the main reasons for their establishment is to help and guide people that are suffering from a road accident experience. Moreover, they also help to prevent and to aware people from the consequences. In other to achieve these goals, they organize and perform mainly three kinds of activities: pre-accident activities (example, road prevention campaigns at schools), post-accident activities (at hospitals, giving psychology and legal counsel to the victims and their families), and tasks devoted to "reoffended users". The third ones try to prevent the offender to repeat the incident again by making them more aware of the risks presented in the road, for example by their participation in road safety conferences. Something to highlight is that road victims participate in these activities, either during the project organization or the project implementation, what gives an important point of view. It is frequent that this type of activities is organized as blocks of "projects", and sometimes these projects are funded by the DGT.

**Table 1:** Problem definition for the students

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**1. Contact and involvement with the Road Victims' Association.**

- 1.1. First contact with the Association.
- 1.2. Participation in the Association's activities as a volunteer.

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**2. Road Victims' Association profiling.**

- 2.1. Legal and organizational structure.
- 2.2. Fundamental activities.
- 2.3. Geographical framework of activities.
- 2.4. Funding sources and their alternatives.

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**3. Activities categorization.**

- 3.1. Activities typology and description
  - 3.1.1. Pre-accident activities.
  - 3.1.2. Post-accident activities.
  - 3.1.3. Reoffended activities.
  - 3.1.4. Other ongoing activities.
- 3.2. Statistics of each road safety intervention.
  - 3.2.1. Legal counsel.
  - 3.2.2. Psychological counsel.
  - 3.2.3. Statistics of other nature.
- 3.3. Aided projects by Directorate General of Traffic.
  - 3.3.1. Number and content of the projects.
  - 3.3.2. Project duration.
  - 3.3.3. Staff assigned.
  - 3.3.4. Final results of each project.
- 3.4. Analysis of the institutional support.

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**4. Improvement proposal for the Road Victims' Association.**

- 4.1. Improvement proposal in the Association management.
  - 4.2. Measures for raise their range of action in road safety.
  - 4.3. Measures for raise their social visibility.
  - 4.4. Suggestions for road safety interventions, road safety education and training.
  - 4.5. Suggestions of new projects.
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### **3 ASSESSMENT OF THE EXPERIENCE: SURVEY ON STUDENT SATISFACTION**

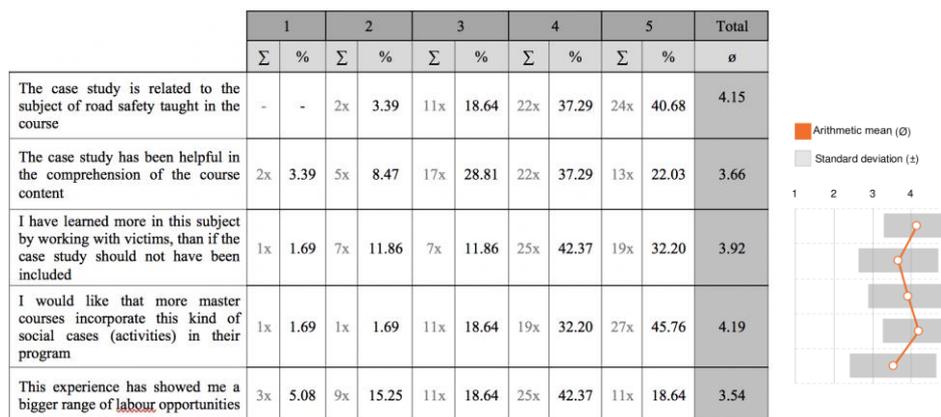
The evaluation of the socio-educational intervention has been carried out through a questionnaire that seeks the opinion of the students about the knowledge on road safety achieved and also about the motivation and social attitude developed on road safety. Surveys on student perception, as mentioned in the state of the art, have demonstrated to be a useful tool to assess the service-learning methodology.

The survey presented to the students was arranged in six different blocks. The first block was composed of 3 items which collected "Yes" or "No" responses and contained questions about students' profile, such as their previous volunteer activities, their prior road safety knowledge and also if they had ever attended a similar teaching experience. Within the next three blocks, different aspects have been compiled: the evaluation of the learning process, the relationship between students and associations and finally the ethical competences acquired. These items were Likert type with 5 different values (1= in total disagreement, 2=disagree, 3=agree, 4= quite agree, 5= totally agree). Data related to the teaching methodology, the comprehension of the course contents and also the employability has also been considered to

evaluate the learning process. Additionally, students' perception about their experience and communication with the different associations has been analyzed (the assistance and training received by the association, the frequency of contact, the provided information by the association, etc.). The ethical competences block was about how the students' perception of road safety has changed after having done this practical case study and also after working with victims, including questions about the importance of road safety in students' everyday life. The fifth block consisted in a rate table to evaluate the teamwork student's experience. The final block included some questions that summarize and evaluate the whole service-learning experience. Each block of results was analyzed based on the statistics for each question, and as all the surveys were anonymous and had an identical format, the distribution did not follow any random procedure.

The students filled this survey on May 9th, 2018 in about 15/20 minutes and was provided to them in a digital format, through a website, collecting information automatically. This fact has facilitated the analysis of the results. Following the already mentioned survey blocks, something to highlight from the students' profile is the higher percentage of students that have not attended to a course that offers a service-learning experience (93.22%). This result confirms that the SL is not implemented at all in the Spanish teaching methodology (Civil Engineering Degrees) and it is an innovative and unknown methodology. For that reason, the results could be only compared with the traditional teaching methodology.

If the Likert type questions are analyzed it is observed that the mean reaches 4 (quite agree). In these terms, it can be stated that this new teaching methodology has been helpful for the comprehension of the course and should be incorporate in more courses. In fact, this experience has affected the students' ethics, causing them to have more social awareness and to become more careful road users. Moreover, according to students this experience has not only helped them from an academic point of view, but also helped them to improve their personal skills, especially according to their team work abilities. An example of these questions could be seen in Figure 2.



**Figure 2:** Answers Likert type questions from Block 2: Service learning experience.

As for the evaluation of personal experience, the students agree that the experience has been very pleasing, helping to raise their awareness of social aspects and, more specifically, of the causes and consequences of traffic accidents. It has all been thanks to the Victims' Associations that have facilitated and shown them this new perspective, which it is based not only in what they are doing, but also about the technical improvements they offer. Finally, it only remains to be mentioned that the majority of the students believes that the case study and the service-learning methodology as an indispensable complement to their education.

#### **4 CONCLUSIONS**

This paper describes an innovative experience of SL in the field of road safety, in which 61 students of higher education (Master of Civil Engineering of UPM-Spain) are divided into groups and assigned a road Victims' Association. Literature reviewed has shown the benefits of the SL methodology, but at the same time little research has been done in the field of road safety with exception to some related cases of public participation. Based on other referenced assessments of SL experiences at higher education, surveys on students' perception have been selected as the most suitable tool to evaluate this pilot experience. Results reveal a students' positive satisfaction with the SL experience on road safety, which has helped them in both technical and human skills and abilities. And all of them are willing to recommend this experience to other students and consider it as a pillar in their academic, professional and personal training.

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