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Assessment of a service-learning project experience in mobility and spatial data

Evaluación de una experiencia de Aprendizaje-Servicio sobre movilidad y datos espaciales

Avaluació d'una experiència d'aprenentatge-servei en mobilitat i dades espacials

Emilio Ortega[1,2,*], Belén Martín[1,2], María Eugenia López-Lambas[2], Cristina Jorquera[3]

1 | Department of Forestry and Environmental Engineering and Management. MONTES (School of Forest Engineering and Natural Resources), Universidad Politécnica de Madrid, Madrid, Spain
2 | Transport Research Centre (TRANSyT-UPM), Universidad Politécnica de Madrid, Madrid, Spain
3 | Universidad Politécnica de Madrid, Madrid, Spain
*Corresponding author: emilio.ortega.perez@upm.es (Emilio Ortega)

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ABSTRACT: To enhance sustainable and walkable cities, we need to know which aspects of the urban environment affect children's walkability and develop measures related to communication and education to ensure widespread awareness in society as a whole. The aim of this paper is to advance the implementation of participative and dynamic techniques at university level and target children from a sustainable mobility perspective. Through the Service-Learning project "Let's Walk to School Safely!" three specific objectives related to learning, service and teaching are addressed. While learning, university students conducted a community service project and resolved several challenges related to complementary skills for pedestrian mobility and Geographic Information Systems, while children learned mobility concepts. Its development combines the resolution of a challenge, learning by doing–since the whole process was carried out in a real context–and cooperative learning. Using the results of a survey of 200 children studying in a school in Madrid, field work, and digital mapping, eight University students developed an interactive online map which classifies the streets around the school according to the children's comfort level, safety/security and ease of travel. The participants broadened their academic competencies while exchanging skills, knowledge and expertise, and also acquired transversal competencies related to teamwork, organisation and planning, effective communication and ICT knowledge.

KEYWORDS: Active learning; Service learning; Undergraduate teaching; Children mobility; Walkability map

RESUMEN: Para conseguir unas ciudades más sostenibles y transitables es necesario conocer qué aspectos del entorno urbano afectan al desplazamiento a pie de los niños y trabajar en medidas relacionadas con la comunicación y la educación para garantizar una concienciación generalizada en el conjunto de la sociedad. El objetivo de este trabajo es avanzar en la aplicación de técnicas participativas y dinámicas a nivel universitario y dirigidas a la infancia en el marco de la movilidad sostenible. A través del proyecto de Aprendizaje-Servicio "¡Caminamos seguros al cole!", se abordaron tres objetivos específicos relacionados con la enseñanza, el aprendizaje y el servicio a la comunidad. Mientras aprendían, estudiantes universitarios realizaron un servicio a la comunidad y resolvieron varios retos relacionados con la movilidad peatonal y Sistemas de Información Geográfica, mientras los niños aprenden conceptos de movilidad. Su desarrollo combina la resolución de un

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reto, el aprender haciendo -ya que todo el proceso se llevó a cabo en un contexto real-, y el aprendizaje cooperativo. Mediante el empleo de los resultados de una encuesta a 200 niños que estudian en un colegio en Madrid, trabajo de campo y cartografía digital, ocho estudiantes universitarios desarrollaron un mapa web interactivo que clasifica las calles que rodean al colegio en función del nivel de comodidad, seguridad y facilidad de desplazamiento de los niños. Los participantes ampliaron sus competencias académicas, al tiempo que intercambiaron habilidades, conocimientos y experiencia, y adquirieron también competencias transversales relacionadas con el trabajo en equipo, la organización y la planificación, la comunicación eficaz y el conocimiento de las TIC.

RESUMEN: Aprendizaje activo; Aprendizaje servicio; Docencia universitaria; Movilidad infantil; Mapa de caminabilidad

RESUM: Per a aconseguir unes ciutats més sostenibles i transitables cal conèixer quins aspectes de l'entorn urbà afecten el desplaçament a peu dels xiquets i treballar en mesures relacionades amb la comunicació i l'educació per a garantir una conscienciació generalitzada al conjunt de la societat. L'objectiu d´aquest treball és avançar en l'aplicació de tècniques participatives i dinàmiques a escala universitària i dirigides a la infància en el marc de la mobilitat sostenible. A través del projecte d'aprenentatge-servei "Caminem segurs a escola!", es van abordar tres objectius específics relacionats amb l'ensenyament, l'aprenentatge i el servei a la comunitat. Mentre aprenien, estudiants universitaris van realitzar un servei a la comunitat i van resoldre diversos reptes relacionats amb la mobilitat de vianants i els sistemes d'informació geogràfica, mentre els xiquets aprenen conceptes de mobilitat. El seu desenvolupament combina la resolució d'un repte, aprendre fent -ja que tot el procés es va dur a terme en un context real-, i l'aprenentatge cooperatiu. Mitjançant l'ús dels resultats d'una enquesta a 200 xiquets que estudien en un col·legi a Madrid, treball de camp i cartografia digital, vuit estudiants universitaris van desenvolupar un mapa web interactiu que classifica els carrers que envolten l'escola en funció del nivell de comoditat, seguretat i facilitat de desplaçament dels xiquets. Els participants van ampliar les competències acadèmiques, alhora que van intercanviar habilitats, coneixements i experiència, i van adquirir també competències transversals relacionades amb el treball en equip, l'organització i la planificació, la comunicació eficaç i el coneixement de les TIC.

RESUM: Aprenentatge actiu; Aprenentatge servei; Docència universitària; Mobilitat infantil; Mapa de caminabilitat

Practitioner Notes

What is already known about this topic

- To enhance sustainable and walkable cities measures related to communication and education to children are needed.
- Service Learning activities combines the active learning process with community service in a well-articulated activity where the students can put into practice, deepen and broaden the knowledge acquired in the classroom, thus obtaining the necessary preparation to address real-world problems.
- Service Learning provides a direct benefit to the targeted community/organisation/group and indirectly to society as a whole, as students complement their academic competencies with the acquisition of values, promoting social inclusion and activating networks of commitment, sustainability and inclusive awareness.

What this paper adds

- It deepens the application of learning experiences based on learning-by-doing, challenge-based learning and cooperative learning methodologies through the development of a Service Learning activity.
- The description of a SL project not developed previously, related with pedestrian mobility, Geographic Information Systems and the generation of online maps, developed by university students and focused on the mobility of children on their way to school.
- It deepens in the application of active methodologies in the field of engineering education, little applied in Spain actually, showing its benefits in the acquisition of their general and scientific competences.

Implications for practice and/or policy

- The described activity, or a similar one, can be extended to all classrooms, with little need of resources for its implementation.
- To leave proof of the importance of active methodologies improve students' learning performance and contribute to the development of their skills.

1. INTRODUCTION

Walking is the most sustainable means of transport, both from an environmental perspective and because it improves people's physical and mental health (Lopez-Lambas, Sanchez, & Alonso, 2021). Not surprisingly, public authorities strive to bring about a modal shift from private cars to walking or cycling. Nevertheless, the experience of walking is not always pleasant or comfortable, as cities tend to prioritise motorised transport over pedestrian mobility. The term "walkability" is used to explain how "good" or "bad" a street is for walking, and is defined by Leslie et al. (2007) as "the extent to which characteristics of the built environment and land use may or may not be conducive to residents in the area walking for either leisure, exercise or recreation, to access services, or to travel to work". A street's walkability is a measure that can be quantified based on specific characteristics of the urban environment (Ortega, Martín, De Isidro, & Cuevas-Wizner, 2020). The scientific literature on transportation and urban planning offers various sets of indicators or measures aimed at accurately measuring factors that describe the quality of the urban environment that affect the public's inclination to walk (Talavera-Garcia & Soria-Lara, 2015). These indicators need to consider the specific needs of the most vulnerable age groups, such as children or elderly people (Martín & Páez, 2019), and should be based on objective, relevant and practical indexes and scales (Delso, Martín, Ortega, & Van De Weghe, 2019; Ewing & Handy, 2009; Leslie et al., 2007; Saelens, Sallis, & Frank, 2003).

To enhance sustainable and walkable cities we need to know which aspects of the urban environment affect children's walkability, while working on measures related to communication and education to ensure widespread awareness in society as a whole (Berasategi, Legorburu, Aliri, & Alonso, 2022; Ferreira & Liu, 2023). Activities in schools can play a key role in this task. In this context, Service-Learning projects (SL) involving universities and primary and secondary schools is an easy alternative that benefits all the parties: undergraduates have a chance to put their knowledge into practice and improve their transversal capabilities, while children learn mobility concepts and become increasingly aware of how to apply these concepts to their daily mobility. Many higher education programmes have incorporated the SL approach into the academic curricula, mainly in the USA (Kohlbry, 2016). Universities should be institutions where students develop both their technical and soft skills (Mtawa & Nkhoma, 2020), and SL helps to foster students' capabilities for citizenship, awareness and civic agency through experiential and transformative learning and critical reflection (Mtawa & Nkhoma, 2020). SL involves the implementation of learning by doing, i.e., it is more than a voluntary service or academic practice, it is an educational method that goes beyond merely completing a few hours of practical work since it entails a critical and creative reflection on the experience. In other words, students learn while solving a problem (Anzai & Simon, 1979). The Technical University of Madrid (UPM) is deploying this technique in several subjects. As an example, the School of Architecture has carried out two projects: "New forms of life for seniors in Madrid" and "One-Health, a healthy urban environment", in both cases through a public-private partnership. A number of final-year dissertations have been completed and been highly rated by the teaching team and the students. SL is coherent with the

Bologna Declaration, according to which education and educational cooperation are key to building and developing the Europe of knowledge. Furthermore, SL activities instil in students a series of ethical values, responsibility, and sensitivity to the social problems they must consider in the exercise of their profession, while contributing to achieving the Sustainable Development Goals (SDG), specifically SDG 4 – Quality education, and SDG 17 – Partnerships for goals, both implicit by definition in the nature of the project. Likewise, the development of these goals targets other SDGs such as climate action (14), good health and wellbeing (3), sustainable cities and communities (11), etc.

The aim of this work is to advance the implementation of innovative educational technologies based on participative and dynamic techniques at university level in the field of pedestrian mobility. Three specific objectives – related with teaching, learning and service to community – are addressed in order to get this general aim. The teaching objective is to propose a methodology that combines the resolution of a challenge, learning by doing and cooperative learning in the development of a SL project, which, as far as we know, has not been developed previously. Through the SL project "Let's Walk Safely to School!", university students —with complementary skills for pedestrian mobility, applications of Geographic Information Systems (GIS) and generation of online maps— consolidate their learning though the development of an interactive web map, which classifies the streets around a school in Madrid according to the children's comfort level, safety and ease of travel on foot. This is the learning objective in the framework of the SL. The service objective of the SL project is related to the need to continue advancing towards more inclusive and safer cities – particularly for children, as one of the most vulnerable populations. Children receive both the map developed by university students and pedestrian mobility knowledge in order to improve their walking experience so that they perceive walking as a healthy way of travelling to school, thereby reducing the use of the private car.

2. LITERATURE REVIEW

Since European countries signed the Bologna Declaration in 1999, the student has become the centre of the teaching and learning process in European universities (Haug, 2017). The current paradigm pivots on the student, who is an active subject in the training activities, while the teacher acts as a guide towards the acquisition of competencies. These competencies should ensure that the students are able to learn throughout their entire life, and allow them to work in those areas demanded by society (Fernández-March, 2006; Rodríguez-Jaume, 2009). In this context, SL activities constitute a perfectly adequate training activity, since they are carried out autonomously by students tasked with solving real problems.

In particular, SL activities represent a shift in traditional teaching, transforming it into the experimental knowledge (Bodorkós & Pataki, 2009) that allows them to complement their university education (McPhail, 2005). It is a pedagogical approach that combines the learning process with community service in a well-articulated activity where the students are trained while becoming involved in people's real needs (Buchanan, Baldwin, & Rudisill, 2002; Torres & Laprida, 2015). Students can put into practice, deepen and broaden the knowledge acquired in the classroom, thus obtaining the necessary preparation to address real-world problems (Finan, 2004; Lee & Perdana, 2023). On the one hand, it offers students the opportunity to develop civic skills by providing service to the community; and on the other it gives them the opportunity to apply classroom knowledge to practical problems for the benefit of the community in which they themselves reside (George, Menon, Thevanoor, & Tharakan, 2020; Tapia, 2000). The literature on SL contains numerous definitions since it has been applied in many areas and contexts. Most authors consider it to be

a learning method based on an educational experience (Dymond, Renzaglia, & Chun, 2008; Goldberg, Mccormick-Richburg, & Wood, 2006; "Service-Learning in higher education: Concepts and practices", 1996) whose main characteristic is community service (Bringle & Hatcher, 1995; Goldberg et al., 2006; "Service-Learning in higher education: Concepts and practices", 1996). Hence, for an activity to be considered SL the project must involve a high level of learning and community service from the student's side (Ortiz-Fernández & Tarifa-Fernández, 2022); the students are guided and advised in this activity by their teachers. In other words, the concepts learned in the classroom must be applied to community service projects, allowing the students to explore concepts more deeply (Dymond et al., 2008).

The SL paradigm was first put into practice by Dewy in the USA between 1938 and 1963, and was later refined and developed by Kolb (1984). This theoretical model maintains that students' learning is reinforced and improved by their active participation. According to Furco (1996), SL aims to engage the students in activities that combine academic learning with community service, in a reality that differs from the classroom. SL can be also considered as a tool for both community development and cohesion (Marcilla-Toribio et al., 2022). Countries such as USA, Canada and the United Kingdom link SL to the need to develop civic responsibility, build a democratic society and answer the challenges facing society (Hall, 2009; McCowan, 2012; Steinberg, Hatcher, & Bringle, 2011). In South America, it is related to solidarity and the struggle against injustice (Tapia, 2004).

SL is being promoted in all the disciplines, and includes experiences of a very diverse nature: from a trip for medical students (Merkey & Palombi, 2020) , to real cases related to social entrepreneurship (Awaysheh & Bonfiglio, 2017) trips to deal with management issues (Leal-Rodríguez & Albort-Morant, 2019), and exercises to show students how to calculate the materials and workforce needed to complete a construction project (Collins & Redden, 2020). SL has been implemented in several health science degrees such as nursing (Plessis, Koen, & Bester, 2013), pharmacy (Kearney, 2013), physiotherapy and medicine (Menamin, Grath, Cantillon, & Farlane, 2014; Merkey & Palombi, 2020). Merkey and Palombi (2020) used it as a tool to enable students to think critically about health disparities and social justice. Griffith, Steinkopf, and Connor (2023) analysed it in the Medicare training field for pharmacy students. The results showed that the combination of didactic learning, patient-case and SL experience produces better results in terms of knowledge, attitude and confidence compared to didactic learning alone. SL has been applied in physical education teacher education programmes, and used with children with developmental disorders on several occasions (Chiva-Bartoll et al., 2019), where it has proved to be a potentially important tool to support the wellbeing of children with ASD (Autism Spectrum Disorder) and their families (Chiva-Bartoll et al., 2019). There are also success stories from the field of engineering. (George et al., 2020) conducted a study of a 10.87 km canal with environmental engineering students in Kochi (India), in which the students used topography, remote sensing and GIS techniques. The results of Valsan, Sreekumar, Chekkichalil, and Kumar (2020) show that engineering students were able to rediscover ways of managing and reusing different types of waste, combining engineering knowledge with community service, to provide a field experience and progressive learning while satisfying social responsibilities. For Bodorkós and Pataki (2009), the SL project facilitated a planning and development process in one of the most socioeconomically disadvantaged rural areas in northeastern Hungary. Some of the main results of this university-community partnership were its contribution to sustainability, including the activation of local capabilities and the creation of networks between various local stakeholder groups through several small-scale projects; and the co-production of a rural development plan with a social and landscape basis for the microregion (Bodorkós & Pataki, 2009). Numerous projects have also been car-

ried out by business schools (Awaysheh & Bonfiglio, 2017; Gittings, Taplin, & Kerr, 2020). Lee and Perdana (2023) examined the impact on student engagement in an accounting course at a large American public university, applying Kolb's learning theory (Kolb, 1984). (Blewitt, Parsons, & Shane, 2018) implemented a SL project in a business communication course, and (Ortiz-Fernández & Tarifa-Fernández, 2022) studied the effectiveness and attractiveness of SL methodologies for students in the field of business and economics. In the training of future teachers, several studies identify the importance of reflection in learning in the education disciplines Baldwin, Buchanan, and Rudisill (2007) (Lamaster, 2001). SL has also been used in many teacher training programmes such as physical education (Lamaster, 2001) , literacy (Baldwin et al., 2007), and even mathematics (Jackson et al., 2018).

SL provides a direct benefit to the targeted community/organisation/group and indirectly to society as a whole, as students complement their academic competencies with the acquisition of values, promoting social inclusion and activating networks of commitment, sustainability and inclusive awareness (Hébert & Hauf, 2015; Martínez-Campillo, Sierra-Fernández, & Fernández-Santos, 2019) as has been proven in numerous publications (Ruiz-Ordóñez, Salcedo-Mateu, Turbi-Pinazo, Novella-García, & Moret-Tatay, 2020). These studies also point out that students develop civic competencies such as empathy, solidarity and a greater awareness of the social reality around them (Ortiz-Fernández & Tarifa-Fernández, 2022) . Merkey and Palombi (2020) found that a SL opportunity established with a community can enable deeper and more trusting relationships, meaning that participants can respond more effectively to the needs and requests of organisations and, for example, not impose their own agendas on developing countries. Students can put into practice what they learn in the classroom for the benefit of the community in which they themselves reside (George et al., 2020) to influence the quality of life in their local communities (Rose, Rose, & Norman, 2005). Some of the main academic benefits gained by SL students include: the students' own academic development (Eyler & Giles, 1999; Mcandrew, 2001); the achievement of independent thinking and self-development of resources (Eyler & Giles, 1999); the development of transversal skills and civic responsibility (Bringle & Hatcher, 1995); the integration of research and teaching activities in a mutual learning process between all actors involved (Steiner & Posch, 2006); the development of professional competencies, including critical thinking (Papamarcos, 2005; Yorio & Ye, 2012) ; the capacity to solve real-life problems (Lisman, 1998); and helping students gain work experience (Zoltowski & Oakes, 2014). Students become more deeply involved in the educational experience, providing independent thinking, self-development of resources and overall improvement of educational outcomes (Eyler & Giles, 1999). The possible disadvantages include: i) the difficulty encountered by students in developing tasks due to their indefiniteness and uncertainty (Bush-Bacelis, 1998) a lack of collaboration from the beneficiaries, mainly due to missed deadlines (Madsen & Turnbull, 2006) iii) the need for extra time in addition to their traditional academic activities (Ortiz-Fernández & Tarifa-Fernández, 2022).

3. PRESENTATION OF THE SL PROJECT ``LET'S WALK SAFELY TO SCHOOL!''

The aim of the service is to create a web map that classifies the streets in the area of influence of the primary and secondary school Santa María de Yermo – FESD in Madrid, based on their comfort, safety and ease of access on foot. This web map would be a tool for children not only to learn about mobility issues, but also to raise awareness about the most sustainable mode of transport: walking. In addition, the identification of the least recommendable streets will allow them to plan their journey in terms of safety. The web map was created by a group of university students from

two engineering schools in the UPM. Then, there are two groups of students involved:

3.1. University students

Eight students (3 female, 5 male) from two engineering schools in the UPM took part in the SL experience. The students are enrolled in the subjects of transport (4th year of Bachelor's Degree in Civil and Territorial Engineering) or advanced GIS (4th year of Bachelor's Degree in Forestry Engineering) or new technologies for spatial analysis and territorial applications (4th year of Bachelor's Degree in Forestry Engineering). This ensures that the working group includes students with a knowledge of all the aspects necessary to solve the challenge: i) pedestrian mobility; ii) management of geo-referenced databases; and iii) creation and publication of online maps.

Table 1 shows the number of students taking part in each activity (see 4.2). The students selected the tasks based on their availability and prior knowledge. One of the students was financially supported, and was also involved in coordinating the work, in addition to participating in all the tasks.

Five university lecturers/associate professors were involved as supervisors of the activities, under the coordination of one of them. One of the associate professors was the project coordinator, responsible for the contact with the school managers.

Table 1. *Number of university students involved in each implementation activity described in 4.2*

Activity	Number of students
Activity 0.1	1
Activity 1.1	2
Activity 1.2	5
Activity 2.1	6
Activity 2.2	5
Activity 2.3	4
Activity 3.1	8
Activity 3.2	1

In terms of learning objectives, SL projects favour university students to improve their academic competencies in: i) knowledge of mobility patterns and preferences of vulnerable population groups; ii) survey design, analysis and utilisation; iii) creation and management of geo-referenced databases in a geographic information system; and iv) design and publication of maps in web environments. In terms of transversal competencies that university students acquire are: i) teamwork; ii) organisation and planning, as they need to coordinate the various subgroups and phases of the project; iii) effective communication when carrying out surveys of the children and in meetings with the school management; and iv) knowledge of ICTs, as all the work is done using computer tools.

3.2. School students

The objective of the service was to provide the 550 Santa María del Yermo students with an interactive walkability map. The students who received the service participated in the process of creating the map, since they themselves, through a survey, incorporated their perception of the most important aspects on their way to school. Specifically, students participated in the project activities summarized in Table 2 :

The school management collaborated in the planned activities with the participation of the children at the school, who played an active part as the beneficiaries of the project. The school students responded to a survey they were sent to identify the

Table 2. Activities described in 4.2 in which school students are involved

Activity	School students participation
Activity 0.1	Participation through meetings with the school management and the project, coordinator who presented the project.
Activity 1.2.	200 school students completed a survey on their walkability to school
Activity 3.2.	The school children participated in two seminars to disseminate among them the results of the project.

factors they believed were more or less important when accessing the school on foot, and attended a seminar to disseminate the project.

4. METHODOLOGY: SL PROJECT DEVELOPMENT

Here we describe the procedure and instruments used. We distinguish two phases in the methodology: the teaching methodology and the implementation methodology proposed to carry out the work assigned to the students, i.e. the learning activities. A monitoring procedure was also established with the aim of ensuring learning and the achievement of the proposed objectives.

4.1. Teaching methodology

The development of a SL project involves applying new learning methods that promote dynamic learning, as opposed to traditional ones. Specifically, the methodologies used in our SL project are learning by doing, challenge-based learning and cooperative learning.

Challenge-based learning. Students are presented with a real, complex problem related to their local environment, and must find the most effective solution to the problem. The problem the students were given was the creation of the web map, for which they had to apply the knowledge acquired in various subjects, adopting a critical and organised attitude.

Learning by doing methodology. This is based on experimentation in a real context, learning to solve the problems the person will encounter in the world of work. The university students have to create a product that will be available on the school website, and establish a working relationship with the school management and with the students in the work team.

Finally, as this group of students comes from different subjects and degrees in the UPM, they also benefit from cooperative learning, as they work in small groups, which favours the exchange of knowledge, coordination and the development of their social competence.

4.2. Implementation

The project was developed and implemented by the university students in four work packages (WP). Each WP includes several activities which are described below. Figure 1 shows the workflow corresponding to learning activities.

WP0 Coordination of the participants in the development of the project's WPs

Activity 0.1. Holding regular meetings with schoolchildren, coordinating teachers and the school management.

The aim is to achieve the effective coordination of the project by holding regular meetings with those involved (schoolchildren, teachers and school management). The learning outcome is to improve competencies in team coordination and monitoring.

WP1: Identification of the factors influencing children's pedestrian mobility

Activity 1.1. Conduct a literature review

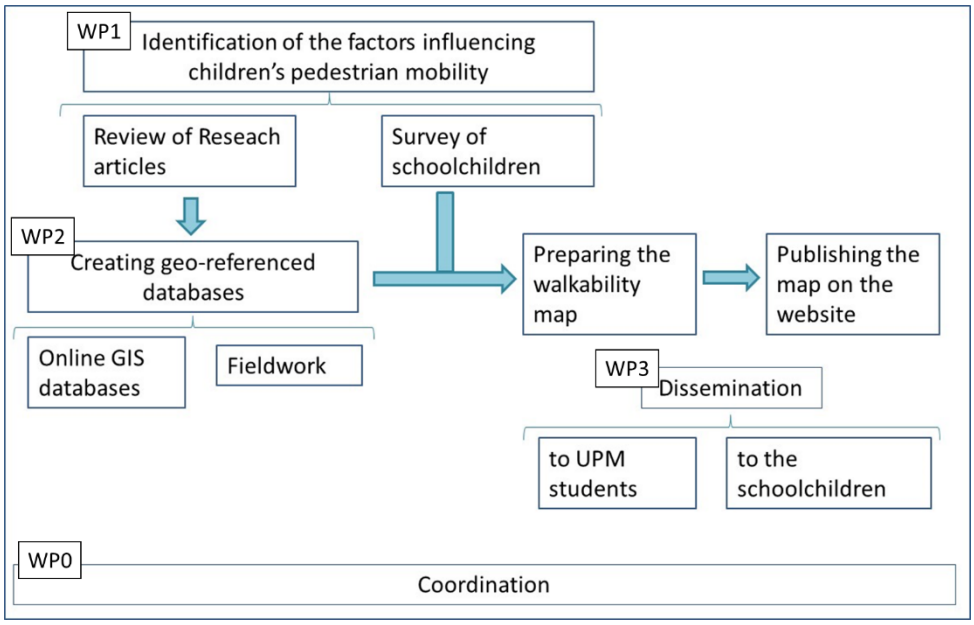

Figure 1. *Workflow. Source: Authors.*

The objective is to identify the factors influencing children's pedestrian mobility by reviewing scientific articles. The learning outcome is to learn how to search for scientific information and its subsequent processing. It also allows students to deepen their knowledge of social and group concepts relevant for urban and mobility planning.

Activity 1.2. Prepare surveys, questionnaires and interviews with the agents involved.

The aim of this activity is to design, create, disseminate and process a survey of schoolchildren based on the results of Activity 1.1. The learning outcome is to learn how to conduct and process a survey. This will enable students to increase their competencies in data processing and statistics.

WP2: Preparation and publication of the comfort, safety and ease map

Activity 2.1. Creating geo-referenced databases

The objective is to search, process and create databases containing the necessary information to characterise streets and auxiliary elements (pavements, furniture, etc.) in the area near the school, taking into account the factors identified in Activity 1.1. It also includes the necessary fieldwork to complete the information. The learning outcome is to increase competencies in database processing and field data collection.

Activity 2.2. Preparing the walkability map

Based on the databases created in Activity 2.1 and the results obtained in Activity 1.2, a map is created using a GIS to indicate the degree of comfort, safety and ease of travel for children on their journey to school on each stretch of road. The learning outcome is to improve competencies in database processing and calculating indicators.

Activity 2.3. Publishing the map on the school's website

The aim of this activity is to design the interactive web map on the ArcGIS Online platform, based on the map produced in Activity 2.2. The learning outcome is to increase students' competencies in designing interactive maps and publishing them in web environments.

WP3: Dissemination

Activity 3.1. Disseminating the activities to UPM students participating in the SL project.

Seminars were organised and given by each subgroup of students to the other subgroups to explain the activities they have developed, so that all the students acquire

competencies in all the activities carried out in the framework of the SL activity. The learning outcome is to broaden knowledge of other disciplines and improve students' communication skills.

Activity 3.2. Disseminating the activities to the schoolchildren.

The objective is to disseminate the activities, methodologies and results obtained in the project to the children in the school.

Two seminars were organised at the school to teach the children about concepts of pedestrian mobility and inform them of the activities carried out, the methodologies used and the results obtained in the project. Each seminar was aimed at children of different age groups: 6-12 years old and 13-16 years old. These seminars were attended by about 400 children. The learning outcome is to improve the students' communication skills.

4.3. Monitoring

In order to monitor the learning process and the achievement of the objective, regular meetings were held by the university lecturers/associate professors with the students. Each subgroup of students met with one of the trainers once a fortnight. A meeting with all the students was held once a month.

The competencies acquired by the students were evaluated by taking into account both the degree of achievement in the resolution of the challenge and their involvement. As the activity was voluntary, this was positively rated in the final mark for the subject. The students completed a satisfaction questionnaire. The questionnaire was designed ad-hoc to collect the university students learning experience. The questions were answered online by university students according to the degree of satisfaction, with a choice of five scores, with the fifth being the highest.

The school monitored and evaluated the results by means of regular meetings between the project coordinator and the school managers. The final impact of the activity on the school's educational community was assessed based on a satisfaction questionnaire to the head teacher. The questionnaire was designed ad-hoc to collect the school manager learning experience. The questions were answered online by the school manager according to the degree of satisfaction, with a choice of five scores, with the fifth being the highest.

Table 3 shows the satisfaction questionnaires given the UPM students and the school head teacher.

Table 3. *Satisfaction questionnaires*

UPM students
Do you think you have learned more than you would have learned in the subject without having participated in the project?
Do you think that the project has helped you to improve your teamwork competencies?
Which activity has contributed the most to your training?
If you were given the choice again, would you repeat?
School head teacher
Explanatory seminar for students aged 6 – 12
Explanatory seminar for students aged 13 – 17
Knowledge acquired by the school students
Web map
Overall development of the project

5. RESULTS

Students were able to apply concepts learned in class and deepen their understanding (Dymond et al., 2008), guided and mentored by teachers. The UPM students achieved their goal and created, as a final result of their learning process, an interactive web map, which was presented at the school. First, after a literature review, they identified the possible factors that influence children's pedestrian mobility and classified them according to whether they are related to safety, comfort and ease. These factors include pavement width, existence of traffic lights, cleanliness of pavements, shade, and the street gradient. Once these factors had been identified, a survey was distributed to all the school students to determine which of these factors they perceived to be most important. The survey was answered by almost 200 students. Geo-referenced databases were then created with the help of a GIS, containing the information that characterises each of the factors in the streets. This was done using free available data and fieldwork, collecting information such as the distance between tree surrounds or the cleanliness of the street. These variables were then used to rank the streets in terms of walkability (safety, comfort and ease) by first transferring all the values for each street to a scale of 0 to 10 for the purpose of comparison. The values were then weighted (on a scale of 1 to 5) according to their importance based on the responses obtained in the school survey. Once each value was scaled and weighted, all the values were added together to obtain the final value for each street. This calculation was done for the total of all the variables, as well as for safety, comfort and ease. The students also explained to other UPM students the activities they had developed.

The result is the service provided to children: a web map to facilitate their pedestrian mobility, where streets are ranked according to the children's comfort, safety and ease of travel level. It is created in ArcGIS Online, and an ESRI Web Experience (www.esri.com) which will be available to any type of user once this web experience is made public. Its layout (see Figure 2) consists of a view of the streets around the school that have been considered the school's area of influence. This view of the streets has three base layer options: a satellite view, and a topographic map from the Spanish National Geographic Institute (IGN). At the top, below the project title, there are two icons for Map layers and Legend. The available map layers are the icon identifying the location of the Santa María de Yermo school, and the layers with the global walkability value and the safety, ease and comfort values. The legend explains the colour used for the streets rated in terms of very high, high, medium and low.

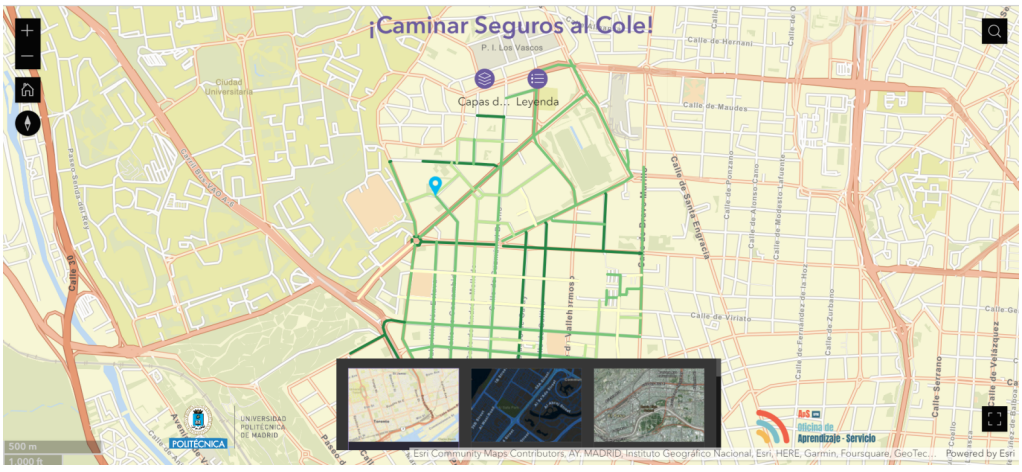

Figure 2. *Web map*

Also as part of the service to children, two explanatory seminars were held at the school on 16 June 2023, with the aim of teaching the school students about concepts of pedestrian mobility, and how the whole project had been developed. These seminars were attended by more than 300 students.

6. DISCUSSION

The development of SL Let's Walk Safety to school!" has enabled students to develop both their technical and soft skills, as is now recognised as fundamental in university studies (Mtawa & Nkhoma, 2020), where the student is the centre of the teaching and learning process (Haug, 2017). The three specific objectives — related with teaching, learning and service to community— have been achieved. Regarding teaching, although SL has been worked on for a long time, with a focus on areas such as nursing, pharmacy, medicine, business or teaching (Gittings et al., 2020; Griffith et al., 2023; Jackson et al., 2018; Kearney, 2013; Plessis et al., 2013), it is less frequent in the field of engineering. Of course, success stories from the field of engineering examples can be found in the literature (Bodorkós & Pataki, 2009; George et al., 2020; Valsan et al., 2020) but none have been found on walkability in the university environment. This SL project has allowed us to complete and transform the traditional teaching into experimental knowledge (Bodorkós & Pataki, 2009; McPhail, 2005).

The participation in the SL project impacted the learning of the students. The satisfaction questionnaires completed by the UPM students showed a high success rate. They all agreed that they learned more due to their participation in the project and that it helped them work better as a team. This is in line with previous studies, which indicate that participation in problem-solving projects contributes to the development of their general and scientific competences (Queiruga-Dios, Sáiz-Manzanares, & Montero-García, 2019). They also reported they would all repeat the experience if they had to take the subject again. Finally, it should be noted that each student benefited more from certain activities depending on their area of participation and their prior knowledge. The fact that students from different subjects have participated in the experience differentiates our SL project from many of the previous SL experiences focused on a specific field of study (George et al., 2020; Griffith et al., 2023; Merkey & Palombi, 2020; Valsan et al., 2020). Some of the activities mentioned as being most relevant are processing the layers, developing the web map, planning the fieldwork and group collaboration. In addition to the technical skills they developed thanks to their participation in the project (web mapping, layer processing, etc.), the students also acquired transversal competencies related to teamwork, organisation and planning, effective communication and ICT. They mainly valued the opportunity to organise and work in a team, displaying coordination and management skills that are not usually present in their university tasks, and resolving real-life problems (Lisman, 1998). Especially relevant was the fact that they came from different academic disciplines (environmental and transport), which meant extra teaching-learning work between the team members (Steiner & Posch, 2006). The fieldwork was also highly valued, as it not only served to collect the data they needed, but also allowed them to observe and learn first-hand about the reality they were facing outside a controlled environment such as the academic setting. The processes of obtaining data, working in a heterogeneous group and obtaining the necessary databases for the final map meant that the experience became something very different —and therefore much more rewarding— from a pre-prepared exercise from their instructors. These kinds of academic benefits are compatible with reports in the literature regarding students' academic development (Eyler & Giles, 1999; Mcandrew, 2001), greater independent thinking and self-development of resources (Eyler & Giles, 1999).

It should be noted that all students reported they would repeat the experience, especially if it were a complementary work to the subject (as was the case). They also highlighted that participation in the project helped them deepen their knowledge of the subjects involved in a practical way and aided their understanding of their respective dynamics. This practical application of their knowledge has enabled them to tackle real-world problems (Finan, 2004; Lee & Perdana, 2023), one of the main benefits of SL. The only difficulties encountered by some students were problems in coordinating with each other to perform the tasks together due to lack of time, and the fact that the SL activity involved extra work that had to be balanced with their other academic activities. This drawback has previously been reported in the literature (Ortiz-Fernández & Tarifa-Fernández, 2022), and should be taken into account when planning future courses. In contrast, they have not reported any difficulties about tasks uncertainly or lack of collaboration from the school, previously identified (Bush-Bacelis, 1998; Madsen & Turnbull, 2006). This is because the project was very well defined and the students had clear the tasks to develop, supervised by the instructors.

The satisfaction questionnaires completed by the school head teacher showed a high success rate. The question on the knowledge acquired by the school students scored a 4, while the rest of the questions (student survey, school seminars, the web map and the overall development of the project) received the highest score. It was also mentioned that the activity had a great impact among older students, who displayed an interest in technical studies. The service done also impacted the UPM students. They perceived that their work had the ultimate goal of providing a benefit to society, which is the underlying principle of a SL (Buchanan et al., 2002). The students had the opportunity to apply classroom knowledge to practical problems for the benefit of the community, as previously mentioned in the literature (George et al., 2020; Tapia, 2000), promoting inclusive awareness and sustainability (Hébert & Hauf, 2015). Through their participation in the project, students contributed to making cities safer and more inclusive by addressing the needs of pedestrians, particularly for a vulnerable population group such as children, linked mainly to SDG-11 “Make cities and human settlements inclusive, safe, resilient and sustainable”, not previously reported in the SL literature. (González-Sánchez, Medina-Salgado, Torrejón-Ramos, González-Mendes, & Alonso-Muñoz, 2022) addressed the contribution of the SL to the SDG-11 in the subject “Tourist Transport”, focusing on the organization of an open conference. Our project is more ambitious from the point of view of generating a product. The map allows the identification of conflictive or dangerous areas to be avoided on children’s trips, thus improving their walking experience so they perceive pedestrian mobility as ideal. This will improve their health and reduce the possible use of private vehicles, and hence the emissions generated. The schoolchildren learned concepts of pedestrian mobility by actively participating in some of the activities. The UPM students were also able to teach the schoolchildren some concepts of pedestrian mobility by encouraging them to actively participate in some of the activities.

7. CONCLUSIONS

The literature shows that teaching based on participatory and dynamic methods in the university environment has multiple advantages. However, there is no existing literature on methodologies that incorporate SL to improve the sustainability of cities and the role of children in enhancing the walkability of cities, particularly in relation to SDG-11, which aims to ”make cities and human settlements inclusive, safe, resilient and sustainable”. Our SL project fills this gap. In the SL Let’s Walk Safely to School! project, university students’ learning is centred around the challenge of developing an interactive web map that identifies the safest, most comfortable and accessible streets

for children to use when walking to school.

Many of the previous SL experiences are focused on one learning method or one particular field of study. Our SL project covers several fields of knowledge and many coordinated tasks. This can serve as an inspiration for the implementation of SL projects with a similar approach, which is very common in the field of engineering. Our study has complied its teaching objective and advances the previous academic work by proposing a methodology that combines the resolution of a challenge, learning by doing – since the whole process was carried out in a real context –, and cooperative learning – as this group of students comes from different subjects and degrees – in the field of pedestrian mobility. Progress has been made in the comprehensive education of university students and in community service by applying the knowledge acquired in their subjects through a multidisciplinary group project, using new information and communication technologies and organising seminars. The UPM students learned coordination and team management techniques while exchanging skills, knowledge and expertise. The learning objective of the SL project has been achieved and the students expressed their satisfaction with the interdisciplinary nature of the experience. The development of the walkability map has meant that the participants broadened their academic competencies in the knowledge of patterns and preferences in the mobility of vulnerable population groups; they prepared and analysed surveys; they created and managed georeferenced databases in a Geographic Information System; and they designed and published maps in web environments. They also acquired transversal competencies related to teamwork, organisation and planning, effective communication and knowledge of ICTs. There were few complications, generally related to the students' difficulty in coordinating when carrying out tasks together due to lack of time.

Regarding the service provided to the children of the Santa María de Yermo school, the SL project has allowed them i) to have a map that they can use to identify the safest, most comfortable and easiest streets to walk on their way to school, and ii) to acquire knowledge related to pedestrian mobility. They have played an active role as the map reflects the sensitivities of this group of children when walking, obtained through a survey where children participated to express their needs. In addition, their participation in the two seminars organised as part of the experience provided an opportunity to convey them concepts related to urban mobility, and pedestrian mobility in particular.

Despite all the benefits identified, the work has a number of limitations. Regarding the outcome of the SL project, the map assigns a numerical value to each street according to its safety, comfort or ease, however, on numerous occasions the travel time will be a determining factor when selecting the route for the children, not choosing the streets identified as most convenient. Nor has it been possible to assess the impact of the map on children's travel to school. As for the monitoring of the university students, the instructors have not evaluated the degree of satisfaction of the students with the work developed by their peers. Finally, due to the large number of participating children, it was not possible to evaluate the level of knowledge acquired by them. These last two aspects related to the evaluation of learning and the quality of the service provided open up lines of research to be taken into account in the future. Even though there is scope for improvement, the instructors are very satisfied with the results, both in terms of the students' learning and their involvement, and with the achievement of the objectives. The application of active methodologies has allowed them to enjoy teaching, as has been previously described in other studies (Martinez-Roig, Iglesias-Martínez, & Lozano-Cabezas, 2023). They have confirmed the benefits of applying active methodologies such as SL, in which training pivots on the student, while the teacher acts as a guide towards the acquisition of competencies.

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