

Service learning in geoscience education

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Service learning (or community-based learning) is an educational approach that combines learning objectives with community service in order to provide a pragmatic, progressive learning experience while meeting societal needs. Students apply the structured knowledge and skills acquired in the academic course while developing a project that deals with a specific social problem while working in a team. In this article, characteristics of a good service learning syllabus and methods for student evaluation are discussed, the roles of students, teachers as well as external partners are described, and the benefits and challenges of this teaching method are listed for the field of geoscience education. Although this approach is more common in social studies curriculum, geosciences have a broad range of suitable topics, some of which are given as examples.

Le Service-Learning (ou apprentissage communautaire) est une approche éducative qui combine les objectifs d'apprentissage avec le service communautaire afin de fournir une expérience d'apprentissage pragmatique et progressive tout en répondant aux besoins de la société. Les étudiants utilisent les connaissances et les compétences structurées acquises dans le cours académique en développant un projet qui traite d'un problème sociétal spécifique et en travaillant en équipe. Les caractéristiques d'un programme de Service-Learning efficace et les méthodes d'évaluation des étudiants sont discutées dans cet article. Les rôles des étudiants, des enseignants ainsi que des partenaires externes sont également décrits et les avantages et défis de cette méthode d'enseignement sont répertoriés pour le domaine de l'enseignement des géosciences. Bien que cette approche soit plus courante dans les programmes d'études sociales, les géosciences ont un large éventail de sujets appropriés, dont certains sont donnés à titre d'exemple.

El aprendizaje - servicio (o aprendizaje basado en la comunidad) es un enfoque educativo que combina los objetivos de aprendizaje con el servicio comunitario para proporcionar una experiencia de aprendizaje pragmática y progresiva al tiempo que satisface las necesidades de la sociedad. Los estudiantes aplican los conocimientos y habilidades estructurados adquiridos durante el curso académico mientras desarrollan un proyecto donde tratan un problema social específico mientras trabajan en equipo. En este artículo, se discuten las características de un buen plan de estudios de aprendizaje en servicio y métodos para la evaluación de los estudiantes, se describen los roles de los estudiantes, maestros y socios externos. Se enumeran los beneficios y desafíos de este método de enseñanza para el campo de la educación en geociencias. Aunque cuando este enfoque más común en el currículo de estudios sociales, las geociencias tienen una amplia gama de temas adecuados, algunos de los cuales se dan como ejemplos.

Introduction

Service learning (or community based learning) is a teaching method by which students apply the structured knowledge and skills acquired in an academic course to the development of a project that tackles a specific social problem, with the aim of enriching the process of acquiring knowledge through critical reflection on the complex social issues and mutual cooperation on a joint project (Preradović, 2009).

This method is innovative, as it changes the learning and teaching experience. Beside the better understanding of the importance of subject studied, this method allows the transfer of knowledge to the wider society. Higher education institutions get the opportunity to approach the local community and influence it actively and positively. When talking of service learning

projects related to geoscience education, the problems are mostly topics related closely to environmental or sustainability issues.

Service learning must not be understood only as internship/fieldwork or volunteering (service). It has components of both, but it is much more than that (Figure 1). In volunteering, students are engaged in the community and gain practical experience without the component of learning outcomes specific for the certain study programme. During internships and fieldwork students gain practical experience fulfilling learning outcomes of a study programme without any civic engagement. Correctly implemented service learning programmes are based on a curriculum achieving both specific learning outcomes and community wellbeing.

For example, risk management of earthquake hazard has important social aspects. Helping in clearing rubble or supplying groceries after an earthquake is service, while measuring active faults in the field is learning. When university students help local civil protection authorities in designing and implementing activities as part of a project

on seismic hazard mitigation to reduce the impact of earthquakes on the community, it is service learning.

The objectives for implementing service learning practice in geoscience courses are: (1) to foster student interest in earth sciences through community service; (2) to enhance university outreach through interactions with communities by helping to solve local geological and environmental problems; (3) to enhance students' learning ability by applying course knowledge to real-world problems; and (4) to encourage the student-centred learning process and team-work as cooperative learning (Liu *et al.*, 2004).

The aim of this article is to: (1) discuss characteristics of a good service learning syllabus with examples of social problems in geosciences; (2) describe stages of a service learning project and stakeholders (students, teachers and external partner) and their roles; (3) discuss student assessment and evaluation; (4) present benefits (together with generic learning outcomes) of service learning; and (5) consider challenges of this teaching methods.

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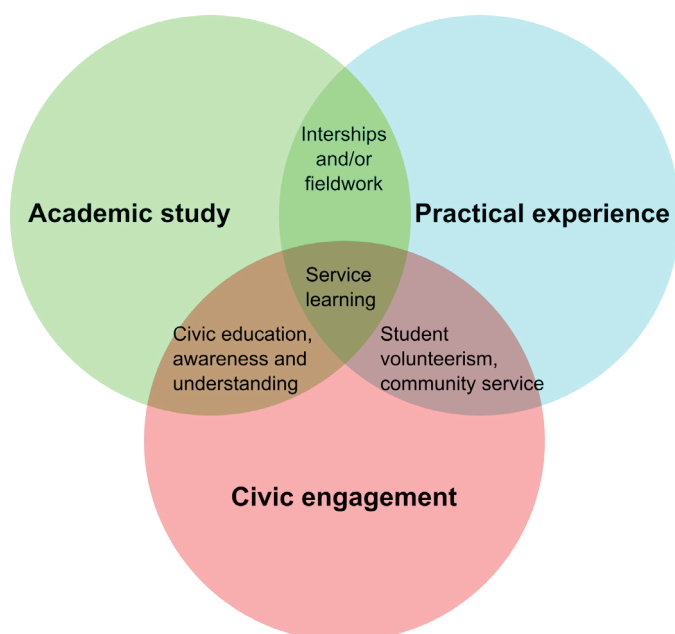


Figure 1: Service learning chart (taken from Fresno State University <http://www.fresnostate.edu/csm/arc/service-learning.html> and modified).

Implementation of a service learning programme

A service learning component can be implemented as part of an obligatory course, part of an elective course, part of courses' cluster which connect students from different study programmes or as a one-person project for a bachelor's or master's thesis. In any case, successful implementation of service learning component means meeting three principles: (1) **reality** (student engagement must be based on detected and previously researched real problems or needs in a particular community which is related to specific learning outcomes of the course); (2) **reciprocity** (exchange of knowledge must be ensured and all parties have to benefit from the program); and (3) **reflection** (revision of the link between engagement and educational content must be ensured).

Service learning in geosciences aims to solve a particular, well-defined geological, engineering, or environmental problem that geoscience students can solve with the knowledge learned in their courses and with supervised guidance from the teachers and local community leaders (Liu *et al.*, 2004). The geosciences are in a central position to promote scientific literacy in our society (Mogk & King, 2018). Real problems or needs in a particular community related to geosciences can be: (1) natural hazards (e.g. volcanic activity, seismic activity, floods, mass movements, erosion, tsunamis, tropical cyclones, etc.),

(2) unsustainable utilisation of natural resources (soil, water, energy resources, non-energy mineral resources); (3) contamination/pollution of water and soil, waste management, landfill placement and design; (4) problems related to medical geology (e.g. natural depletion of nutrient elements or enrichment of potentially toxic elements); (5) geological heritage (e.g. design of an educational geological trail); (6) consequences of climate change, etc. All of these topics provide a clear connection between the physical, life and social sciences. Hence, almost all courses in the geoscience's curriculum can implement a service learning component.

Every course syllabus with a service learning component should include service as an expressed goal; it should (modified after Heffernan, 2001):

- clearly describe how the service experience will be measured,
- specify the roles and responsibilities of students in the project;
- specify how students will be expected to demonstrate what they have learned in the project;
- include a description of the reflective process; and
- include a description of the expectations for the public dissemination of students' work.

It should be borne in mind that this teaching approach requires a significant amount of time for all parties involved. Hence, when planning a syllabus, it is

important to anticipate student workload in preparing and implementing service learning project and assign the appropriate number of ECTS credits (1 ECTS credit indicates 25-30 hours of student workload).

Success of the service learning project depends on all stakeholders, students, teachers, and external partners. External partners can be found based on the specific project from the pool of non-profit and non-governmental organisations, public institutions, educational institutions, etc. The external partner can be chosen by joint agreement between teacher and student; by independent selection of students; or by independent selection of the teacher.

For social problems/needs related to geosciences, good external partners could be public nature protection institutions (e.g. for geological heritage projects); schools and libraries (for projects with the goal to raise the awareness of wider society about natural hazards); or environmental associations. Clear guidelines for external partners are necessary for successful project implementation.

Five stages of service learning project

Using the work of Berger Kaye (2010), the process of service learning can best be understood through the five stages (Figure 2): (1) investigation; (2) preparation; (3) action; (4) reflection; and (5) demonstration. They are linked together and often experienced simultaneously.

Investigation includes both the list of student interests, skills, and talents, and the social analysis of the topic (related to the course-specific learning outcomes) being addressed. **Preparation** includes the acquisition of knowledge that addresses any questions that arise from the investigation (e.g. academic content; identification of external partner; project management with clarification of roles, responsibilities and timelines; etc.). **Action** includes the implementation of the project, which can be in the form of direct service, indirect service, advocacy or research. **Reflection** is the link between each stage of service. Through reflection students consider their thoughts and feelings (cognition and affect), which helps in their future plans and self-awareness. Students can use discussion or journal writing for reflection. **Demonstration** captures or contains the totality of the experience including what has been learned, the process of learning, and the service or contribution accomplished. Students can demonstrate this to their peers, faculty, parents, and/or community members in the form of a report, article, web site, presentation, etc.

Stakeholders roles and student assessment

Each group of stakeholders has its own role; however, the communication inside the student team as well as between students and teacher and external partner is crucial. Students are responsible for project planning and managing. All members of the student team must be involved in project activities, keep a work diary and communicate with other stakeholders regularly. The teacher is obliged to define learning outcomes, monitor the quality of goals set and activities, encourage critical thinking, and ultimately evaluate students. The external partner defines the social problem/need, supervises and monitors the progress of students, and evaluates them.

Critical thinking and reflection are the key to successfully mastering service learning. Hence, students should autonomously or with the teacher decide which activities to use for reflection and to report on the progress of their projects. These can include a work diary; oral discussion, listening and reading about mutual experiences; written analysis of the relation between experiences and course objectives, and many more options. It is important to reflect on everything before, during and after the project.

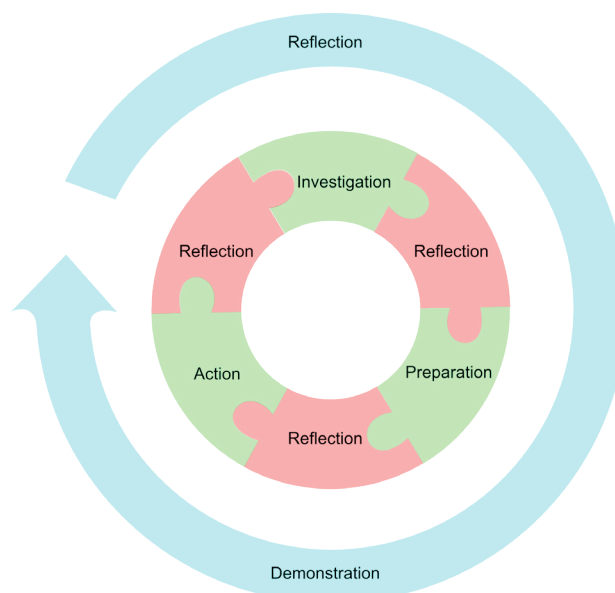
As it is not necessarily the case that every service learning project succeeds, the assessment of students by teachers must be based on the evidence provided by the students themselves, and not only on evidence of socially beneficial activities performed. The evaluation of the service learning project can therefore be carried out as follows (Begić *et al.*, 2019): (1) interview with a mentor from the partner institution; (2) interview with a student project leader; (3) analysis of project documentation and time log; (4) evaluation of student products/services; and (5) assessment of students in the team on the engagement of other team members.

Benefits of service learning implementation in the curriculum

The general value of service learning is fact that this method affects students, teachers, and the community equally. Students get an insight into the ways of implementing the acquired knowledge in practice which have benefits for the community. Teachers gain deeper insight into the skills and competences of students which are not always so easily recognisable in the traditional educational environment. The community gains academic help in dealing with some of its problems.

The main benefit of service learning for students, beside acquiring subject-specific

Figure 2: Five stages of service learning, modified after Cathryn Berger Kaye (2010).



competences, is the development of generic (key) competences, i.e. a set of skills, attributes, and values which should be acquired by all graduates regardless of their discipline or field of study. These include such qualities as critical thinking, intellectual curiosity, problem solving, logical and independent thought, effective communication and related skills in identifying and managing information; personal attributes such as intellectual rigour, creativity and imagination; and values such as ethical practice, integrity and tolerance. As the students work on a geological problem relevant to the local community in a way that is project based, they gain the ability to design and manage projects (which includes abilities to identify, pose and resolve problems; to plan and manage time and finances; to work in a team; to take initiative; to apply knowledge in practical situations). Since service learning projects are focused on local community problems, students gain interpersonal and interaction skills that are difficult to obtain in the traditional higher education environment. Those skills are the ability to communicate with non-experts on themes from geosciences; to adapt to and act in new situations; to motivate people and move toward common goals; to act with social responsibility and civic awareness.

As the social problems related to geosciences are mostly connected to environment-related issues such as pollution, geo-hazard and risk management, and resource utilisation, through work in service learning projects students acquire a commitment to the conservation of the environment. Ultimately, they become more aware of their own profession – geologist/engineering geologist/geological engineer.

The benefit for higher education institu-

tions, beside raising awareness of the impact and application of academic knowledge to the community and its needs and understanding and structuring one's own social responsibility, is building a positive image of a higher education institution.

The external partner benefits, as through implementation of the service learning project, it gains the ability to deal with problems in the community with the help of academic knowledge and to detect new opportunities and spaces for action.

In service learning projects students become equal actors in the teaching/learning process as they are encouraged to engage in critical thinking about the world around them. This type of engagement facilitates simultaneous involvement in social and business processes because students collaborate with organisations outside education system. The end result is, beside a better quality of knowledge, sometimes even provision of a workplace (Begić *et al.*, 2019).

Challenges of service learning

Implementing a service learning program requires careful planning and allocation of time and effort, as well as reflection on the chosen problem. That can become very challenging for all stakeholders involved.

The main challenges for students could be the collision of planned activities in service learning project with other obligations; lack of time for implementation of all designed activities for the duration of course; fear of unknown associates; logistical challenges; poor interpersonal relationships and team organisation; and unequal participation of all team members in project planning and implementation.

The main challenges for higher education institutions could be a possible lack of control over students' knowledge acquisition, organisation and implementation of student's activities; more demanding forms of student assessment; lack of time to help all students with challenges they face.

The main challenges for external partners could be a lack of time for preparation, training, work and supervision of all students; insufficient understanding of the benefits that a service learning programme provides; difficulties in recruitment of students; difficulties in defining service learning activities that are clearly associated with learning outcomes.

Examples of good practice

The National Academies (2017) organised a workshop where perception of experts in geoscience education research was explored and key goals and strategies for integrating service learning in the geosciences were identified. The study found that service learning, in the geosciences, falls at the intersection of practical experience, community involvement, and academic study. Two primary strengths of service learning instruction identified by participants included (1) promoting 'different kinds of learning' and (2) engaging 'faculty and communities' (Donaldson *et al.*, 2020).

Service learning practice has been implemented in several upper division geosci-

ence courses (engineering geology, environmental geophysics, exploration seismology, and geology and geophysics field schools) taught at the University of Connecticut. The participating students and local community leaders found it effective to improve geological undergraduate learning. It has the capacity to foster learning, teaching, and undergraduate research, and facilitates multi-lateral interactions among students, faculty members, and local town public work professionals (Liu *et al.*, 2004).

There are many such examples from the USA in the literature. Unfortunately, service learning in geosciences in Europe is not so visible, although it certainly exists in some forms. Still, service learning is recognised in European higher education in general. The *European Network of Service Learning in Higher Education*, launched in 2017, is an intersectoral, international and multicultural network of European professionals that promotes service learning as a pedagogical approach based on scientific evidence that embeds and develops civic engagement within higher education students, staff and the wider community (www.eoslhe.eu/history/).

Conclusions

Service learning is an innovative teaching method because it changes the learning and teaching experience - for both students and teachers. It integrates profound community service or engagement into the

curriculum, offering academic credit to students for active engagement within the community on a real-world problem which leads to learning outcomes achievement. It brings together students, teachers and the community, whereby all become teaching resources, problem solvers and partners. In addition to enhancing knowledge, the overall purpose is to implant in students a sense of civic engagement and responsibility leading to positive social change within society.

Service learning has been widely adopted in the social sciences and humanities at the higher education level. Unfortunately, this is not the case with natural sciences and engineering, especially geoscience. There is a broad range of specific learning outcomes in geosciences study programs which could be achieved by implementing this teaching approach. Unfortunately, when searching the literature and Internet resources, it seems that it is much more recognised by teachers in geosciences in the USA than in the European Union.

Nowadays, when geoscience study programmes in Europe face a serious challenge to attract students, service learning with real science and engineering at its centre has the potential to raise the awareness of the study programme and interest in geosciences in the wider society.

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