

Community Engaged Learning: A Building Engineering Case Study

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ABSTRACT: Community engaged learning is a form of experiential education with a civic underpinning. Community engaged learning is embedded with the civil engineering curriculum at NUI Galway and is framed by a research orientation, commitments to civic engagement and building university-community partnerships, city-university partnerships and partnerships with other official agencies, so that community users can provide real learning problems and contexts for students and researchers and benefit from the results. This paper presents the positive experience of the authors in facilitating over 300 community engaged learning projects undertaken by undergraduate students in civil engineering at NUI Galway. The paper highlights how well the outlined approach fits with the ideas of engaged scholarship and civic professionalism. Students recognise the long-term value of engaging with community partners, understanding their future role in the community as engineers, reinforcing the idea that their work can respond directly to real needs in the community.

KEY WORDS: Civic engagement; Community engaged learning; Service learning; Civil engineering; Engineering projects;

1 INTRODUCTION

1.1 Community engaged learning

There is a critical need to provide engineering students with a deeper understanding of the general concepts and principles of engineering, and to provide them with the means to meet the challenges of the 21st Century [1-4]. The Royal Academy of Engineering [1] highlighted the need for “*university courses to provide more experience in applying theoretical understanding to real problems*”. Several accrediting bodies for engineering qualifications have developed outcomes-based criteria for evaluating programmes. Similarly, a number of engineering regulatory bodies have developed or are in the process of developing competency-based standards for registration. Educational and professional accords for mutual recognition of qualifications and registration have developed statements of graduate attributes and professional competency profiles. These accords are the Washington, Sydney and Dublin Accords, which are the international agreements providing for mutual recognition of programmes accredited for professional engineers, engineering technologists and engineering technicians, respectively. In relation to graduates understanding the role of engineering and technology in society, a Washington Accord programme provides “comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability”, a Sydney Accord programme provides “Comprehension of the role of technology in society and identified issues in applying engineering technology: ethics and impacts: economic, social, environmental and sustainability” and a Dublin Accord programme provides “Knowledge of issues and approaches in

engineering technician practice: ethics, financial, cultural, environmental and sustainability impacts” [5].

Community engaged learning and teaching are academic approaches that seeks to engage and accredit students, within the curriculum, for working in partnership with civic and civil society organisations (CSOs) to act on local societal challenges [6]. Working in collaboration with community organisations enables students to use and enhance skills, competencies and knowledge in a real world capacity, which leads to an enlarged and more fulfilling educational experience [7]. Through community engaged engineering projects, students can (i) develop the ability to identify, formulate and solve engineering problems in their field of study in a real world context; (ii) select and apply relevant methods from established engineering practice by critically using appropriate sources of information to pursue detailed investigations and research of technical issues in their field of study, (iii) recognise the importance of non-technical –societal, health and safety, environmental, and economic – constraints, and (iv) develop the ability to communicate effectively information, ideas, problems and solutions with engineering community and society at large. In fact, community engaged engineering projects can help fulfil all seven programme outcomes required by Engineers Ireland the education standard required for the registration of Chartered Engineers in Ireland [8]:

- (a) Advanced knowledge and understanding of the mathematics, sciences, engineering sciences and technologies underpinning their branch of engineering.
- (b) The ability to identify, formulate, analyse and solve complex engineering problems.
- (c) The ability to perform the detailed design of a novel system, component or process using analysis and interpretation of relevant data.

(d) The ability to design and conduct experiments and to apply a range of standard and specialised research (or equivalent) tools and techniques of enquiry.

(e) An understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment.

(f) The ability to work effectively as an individual, in teams and in multidisciplinary settings, together with the capacity to undertake lifelong learning.

(g) The ability to communicate effectively on complex engineering activities with the engineering community and with society at large.

1.2 Community engaged building engineering projects

National University of Ireland (NUI) Galway formally committed to civic engagement in 2001 through the establishment of the Community Knowledge Initiative (CKI) [9] to work on mainstreaming community engaged learning within the curriculum across the institution. To date, the majority of undergraduate and postgraduate degree programmes in the School of Engineering have embedded community engaged learning, which allowed students to work with and in local and international communities, and multidisciplinary groups as part of their academic courses [10]. Goggins [10] showed how community engaged learning and teaching in engineering education at NUI Galway can be intergraded at levels ranging from undergraduate modules to post-graduate models and how this can be a lens through which the global dimension of engineering can be integrated into the curriculum.

This paper presents findings and reflections from 11 years' experience of the authors' facilitating over 300 community engaged building engineering projects for second year undergraduate civil engineering students in Ireland. The projects are based around the student groups developing solutions for real-world problems identified by civic society organisations. The projects are framed by a research orientation, commitments to civic engagement, building university-community and city-university partnerships, and partnerships with other official agencies. Such framing means that community users can provide real learning problems for students and community partners can benefit from the results.

The paper highlights how well the outlined approach fits with the ideas of engaged scholarship [11] and civic professionalism [12]. Students recognise the long-term value of engaging with community partners, understanding their future role in the community as engineers, reinforcing the idea that their work can respond directly to real needs in the community.

2 METHODOLOGY

2.1 Community engaged building engineering projects

The community engaged building engineering projects are part of the second year undergraduate Principles of Building module. This module is compulsory for all students in Civil Engineering, Project and Construction Management and Energy Systems Engineering (approximately a total of 60 students per academic year). The general learning objectives for the projects include:

- Developing engineering skills through a self-directed project;

- Developing a sense of commitment to local communities by making a contribution of time and expertise to an individual or community group;
- Learning how engineers in-career make contributions to their communities;
- Applying knowledge or skills learned in this module (and others) to a real-world context;
- Producing a technical engineering report;
- Delivering a high quality oral presentation on a particular subject.

The projects are carried out following a step-by-step methodology which encourages students' engagement and self-evaluation (Figure 1).

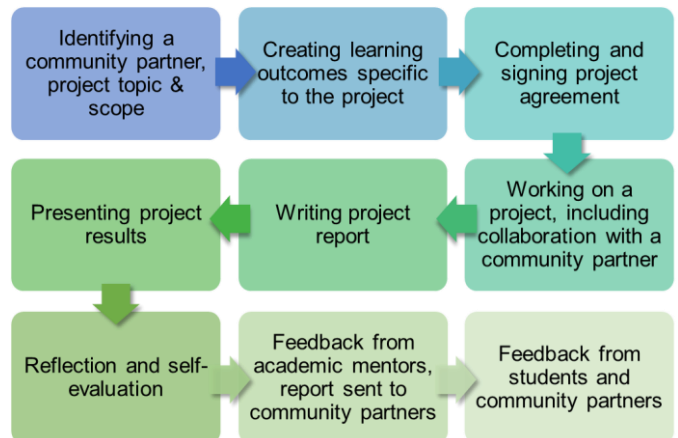


Figure 1. Community engaged building engineering projects methodology.

At the start of the project, students (working in groups of two or three) engage with community partners to identify a potential topic and scope for their engineering project. Community partners may include charity organisations, city and county councils, youth organisations, schools and universities, sport clubs, public organisations/offices, etc. Once the students identify a community partner and a project topic, they create learning outcomes of an individual nature for their project, and complete and sign a learning agreement with the community partner. Identifying the project, its outcomes and completing and signing an agreement with the community partner increases the students' sense of ownership of their learning and gives them freedom to work on a topic of interest within the broader realm of the module area. Many students appreciate the freedom that they are given to specify objectives of the project. However, an outcome of the project must fulfil a 'real' need of the community partner. In the recent feedback survey the students mentioned (Student feedback, 2020):

- *'I liked being given a problem and looking for a solution interdependently, rather than being focused in on finding the correct way to bring about a solution that had already been formulated. Freedom.'*
- *'[The project] gives creative freedom to the students.'*
- *'I liked the practicality of the project and the freedom of choice on which area we could choose to work on.'*
- *'I enjoyed the group work and the ability to engage with a community partner in a real world engineering scenario.'*

Once the agreement with a community partner is signed, students have approximately 7 weeks to complete the project,

which includes researching the topic, carrying out engineering design/evaluation and writing up an engineering report. During this time, students are encouraged to attend drop-in clinics run by teaching assistants who can provide guidance on the project work and assess progress. Technical workshops on project stages, technical writing and presentation skills are also provided as part of the drop-in clinics.

When submitting a project report, students must complete a self-assessment form, where they reflect and assess their project based on its knowledge base, relevance, impact on society, and structure and presentation. Students later receive feedback (from the academic mentors) on their projects based on this self-assessment form. This way, the students know what is expected of them and can compare their and the reviewer's assessment of the project. This makes students aware of the characteristics of 'good work', encourages them to take responsibility for their own learning and helps them reflect on themselves as learners [13].

Following the submission of a project report, students present their project results in the form oral presentations in front of their class, research students, engineers, a communication expert and community partners. Both the project reports and presentations are assessed based on their technical and presentation/communication merit. Thus, students learn not only how to carry out an engineering project, but also how to communicate it to various stakeholders.

Finally, students (and community partners) are asked to provide feedback on their experience with community engaged learning.

Crucial elements of the community engaged projects' set-up include:

- Detailed and structured guidance document for students;
- Structured learning agreement template that must be completed by the students and their community partner at the start of the project;
- Self-assessment form and marking sheet for reviewers;
- Marks are returned to the students with feedback within two weeks of submission of the project and before the end of semester;
- Reports are sent to the community partners who are asked to return feedback to the University.

2.2 Evaluation survey

An important part of ensuring that the community engaged building engineering projects meet the needs of students and community partners are feedback surveys. To date, there were six online feedback surveys carried out among the community partners (2012, 2013, 2014, 2017, 2019 and 2020) and five feedback surveys carried out among students (2009 and 2011 in class; 2012, 2019 and 2020 online). This resulted in 51 community partners providing feedback about the project set-up and 73 students' responses.

The community partner survey sought feedback on students' engagement with community partners, the usefulness of project report, any positive and negative aspects of the project set-up and suggestions for improvement.

The student survey included descriptive questions, such as:

- *What did you like about the project and how it was set up?*
- *What do you gained from completing the project?*
- *What about how the project is run needs to be improved?*

- *What suggestions can you offer that would help make this project a more valuable learning experience for you?*
- *What suggestions can you offer that would help make this project a more valuable experience for your community partner?*

3 RESULTS

3.1 Community partner survey

The results of six feedback surveys carried out among community partners showed that the majority of students' interaction, communication and cooperation was excellent, with approximately 10-20% of partners expressing room for improvement in this aspect (Figure 2). No community partner felt that students interacted, communicated or collaborated in a poor manner through the projects. Furthermore, the majority of community partners found the students' reports very useful and will carry out the recommendations suggested in the reports (Figure 3).

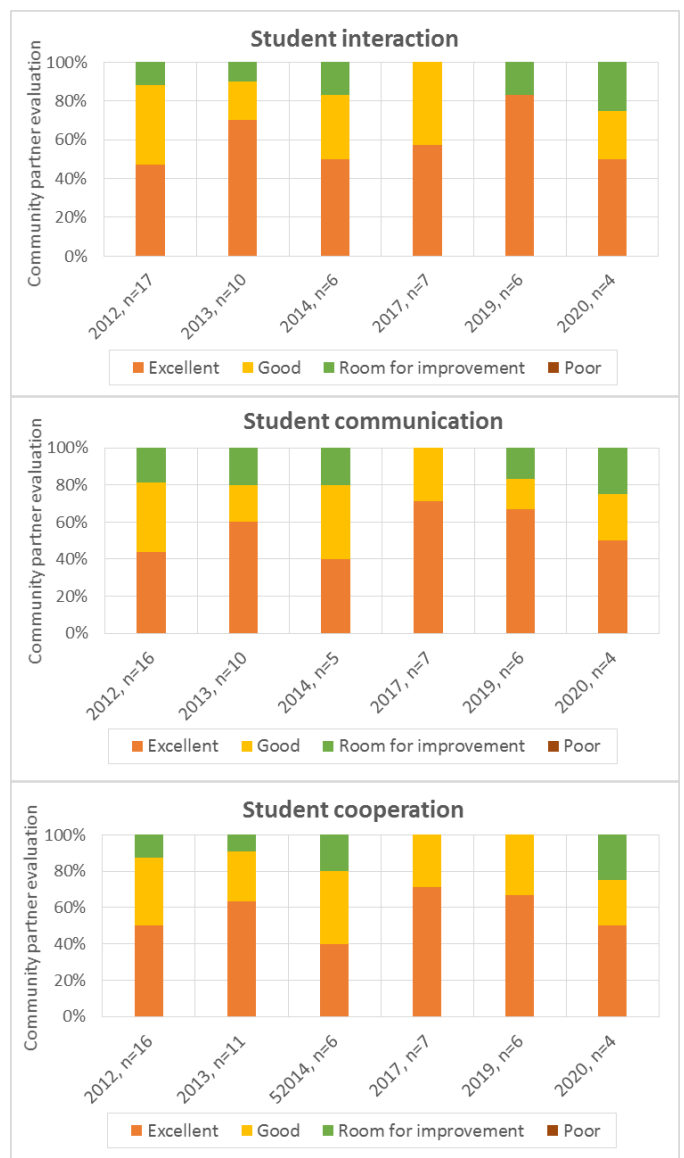


Figure 2. Evaluation by community partners of students' interaction, communication and cooperation.



Figure 3. Evaluation by community partners of the usefulness of project reports.

In terms of positive aspect of the project set-up, the community partners mentioned:

- *'Fantastic to experience cross disciplinary work and I have the sense that the Engineering students benefitting from visiting and engaging with homeless services.'* (Community partner feedback, 2014)
- *'Makes projects possible that could not be afforded otherwise.'* (Community partner feedback, 2013)
- *'It's great that students can give something back to the community as part of their course, it's a boost for the project and vital real world learning experience for the students.'* (Community partner feedback, 2012)
- *'It was rewarding to work with young people.'* (Community partner feedback, 2012)

When asked whether they would be interested in working with NUI Galway engineering students again as part of a community engaged project, over 80% of community partners responded yes and the remaining being undecided (Figure 4). No one claimed they would not get involved in the projects again.

The community partners also made some suggestions for improvement, including extending the timeframe for the projects, incorporating the community engaged projects into undergraduate and postgraduate research projects, disseminating and communicating project results to general public to show how engineering students contribute to the wider community.

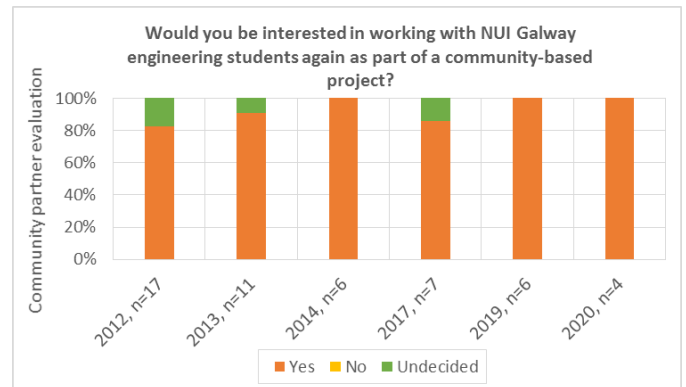


Figure 4. Community partners' interest in being involved in community engaged projects again in the future.

3.2 Student survey

The feedback from students was very important in the development of the community engaged projects module in 2009 and has continued to help the module's improvement to date (e.g. inviting community partners to final presentations or increasing ECTS credits for the project from 2 ECTS to 5 ECTS).

In the first year (2009), the projects ran as a pilot, where it was optional for the students to undertake a community engaged project. After analysing feedback from students, it was decided to make it mandatory that all students in Civil Engineering and Project and Construction Management must complete a community engaged project in the second year of their degree programmes (Energy Systems Engineering students undertook the projects from 2011). In 2011, a grouped student evaluation was carried out, where students were asked to complete the survey in the groups. Since 2012, all students have been asked to complete an online survey at the end of the module.

During the pilot run of the community engaged projects, students felt that they had received enough support from their lecturers and community partners they worked with. Half of the students who completed the community engaged projects felt that they had to spend more time working on their projects, than if their project had not been community engaged. It was apparent that the students who completed community engaged projects were exposed to similar challenges as those in the professional career. These include difficulties organising meetings, learning to deal with deadlines, and being responsible to a client (in this case the community partners). It was interesting that feeling responsible to the community partner was described as a negative by some students, since they felt under pressure and forced to work harder in order to produce a high quality project that meets the needs of the community partner. It was, however, a valuable experience for the students in their future careers as engineers.

In the following surveys, students described their experience with community engaged learning as:

- *'[I feel I gained a lot] working as a team, looking into a project that we choose without much instruction.'* (Student feedback, 2012)
- *'I feel that I gained more of a social experience from the project than engineering experience.'* (Student feedback, 2012)

- ‘[I liked the] sense of freedom to an extent, chance to do meaningful work and explore an area of interest.’ (Student feedback, 2019)
- ‘I liked the hands on nature of the project.’ (Student feedback, 2019)
- ‘I feel as if I have actually completed an engineering project that will be relevant to my future studies. The teamwork, engineering and presentation skills developed exceeded my expectations.’ (Student feedback, 2019)

4 CONCLUSIONS

Evidence collected from the projects shows that, by creating community engaged learning, the students’ energy in learning can have a positive impact on the community. Their energy and enthusiasm can be better utilised by setting assignments as real community engaged projects. The students get a sense of pride and satisfaction out of the knowledge that their work may be helping communities. The projects can increase the students’ sense of ownership of their learning.

Learners are more motivated when they can see that their work has an impact on others [14, 15]. The projects allow the students to achieve all of the programme outcomes specified for an accredited engineering degree [16]. Introducing community engaged learning into an engineering degree programme is a very effective way to fulfil the Washington Accord programme requirement to provide “comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability”. Finally, students recognise the long-term value of engaging with community partners, understanding their future role in the community as engineers, reinforcing the idea that their work can respond directly to real needs in the community.

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REFERENCES

- [1] The Royal Academy of Engineering, *Educating engineers for the 21st century*, London: Royal Academy of Engineering, 2007.
- [2] Jamieson L.H.& Lohmann J.R., *Creating a culture for scholarly and systematic innovation in engineering education*, Washington D.C.: American Society for Engineering Education, 2009.
- [3] Sheppard S., Macatangay K., Colby A., Sullivan W.M., *Educating engineers: designing for the future of the field*, San Francisco: Jossey-Bass, 2009.
- [4] Atman C.J., Sheppard S.D., Torns J., Adams R.S., Fleming L.N., Lund D., *Enabling engineering students success; Final report for the advancement of engineering education*, Washington D.C.: Morgan & Claypool Publishers, 2010
- [5] International Engineering Alliance (IEA), *Graduate Attributes and Professional Competencies*, Version 3, 21 June 2013, Available at <http://www.ieagrements.org>.
- [6] Campus Engage, *Community Engaged Teaching and Learning*, Dublin: Campus Engage, Available at <http://www.campusengage.ie/our-work/making-an-impact/community-engaged-teaching-and-learning/>
- [7] Randles E, Harmon L, *A Student Guide to Community Engagement*, Dublin: Campus Engage, 2015.
- [8] Engineers Ireland, *Accreditation criteria for professional titles*, Dublin: Engineers Ireland, April 2014.
- [9] CKI (2020), *Community Knowledge Initiative at NUI Galway*, 2020, Available online at <https://cki.nuigalway.ie/>
- [10] Goggins J. (2014). Level, distribution depth. In *Integrating GDE into the Academia*, GDEE (eds), Global Dimension in Engineering Education, Barcelona, 2014. Available from <http://gdee.eu/index.php/courses-we-offer/course-7.html>
- [11] Boyer, E (1996), *The scholarship of engagement*, Journal of Public Outreach, Vol. 1 No. 1, pp. 11-20.
- [12] Sullivan, W (2005), *Work and Integrity: The Crisis and Promise of Professionalism in America*, Jossey-Bass, New York, NY.
- [13] Race, P. (2007), *The Lecturer’s Toolkit*, 3rd ed., Routledge, London.
- [14] Bransford, J.D., Brown, A.L. and Cocking, R.R. (Eds) (2000), *How People Learn: Brain, Mind, Experience and School: Expanded Edition*, Commission on Behavioural and Social Sciences and Education (CBASSE), National Research Press, Washington, DC.
- [15] J. Goggins, (2012), *Engineering in communities: learning by doing*, Campus-Wide Information Systems, Vol. 29 ISS: 4 pp. 238 – 250
- [16] School of Engineering (2020), National University of Ireland (NUI) Galway, Galway, Ireland. Available online at <http://www.nuigalway.ie/engineering-informatics/>