CHALLENGE BASED LEARNING: CULTIVATING SOCIAL RESPONSIBILTY IN A COMMUNITY CONNECT COURSE

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ABSTRACT

The uplift of globalization and the implementation of cutting-edge technology have had a drastic effect on engineering education thus the demand for engineers who are not only good technically but also are conscious of the society and community is increasing day by day. The Community Connect course of SRM Institute of Science and Technology is conceptualized under the Challenge Based Learning (CBL) framework to prepare students for social responsibility, ethics, and collaborative problem-solving in the engineering sector. Students are involved in real-world community challenges that encourage technical competence with empathy through interdisciplinary teamwork. Implemented with the ADDIE model, the course was designed as follows: analysis, design, development, implementation, and evaluation phases, and aligned to CDIO standards 2, 5, 7, and 11. In 2024, 600 students from Computer Science, Electronics and Communication, Electrical and Electronics, and Mechanical Engineering disciplines successfully completed 115 community engagement projects that address societal challenges aligned with Sustainable Development Goals (SDGs). The projects were a combination of the development of students' CDIO skills, and the accentuation of the ethics in the practice and service of the engineering. The assessments revealed a considerable step forward in their higher-order thinking skills, teamwork, and practical problem-solving. This paper documents the course design and outcomes toward a model for embedding social responsibility into engineering curricula to meet the changing demands of society.

KEYWORDS

Challenge Based Learning, ADDIE Model, Understanding by Design, Community Engagement, Standards: 2, 5, 7, and 11.

INTRODUCTION

Rapid technological progress and globalization demands that future engineering graduates be technically competent and socially conscious and capable of solving complex societal problems (National Academy of Engineering 2004). Engineering education which has been traditionally meant for building technical competence is being emphasized to include social responsibility and community engagement as part of its curriculum (Sheppard et al., 2009). This development in engineering education, reflects the realization that engineers are probably one of the most impactful groups of people in society and they will have to learn how to cope with ethics, environment, social dimensions on their work. Under this need, with the help of pedagogical frameworks such as Challenge-Based Learning (CBL) is becoming increasingly popular among existing models that stimulate critical thinking, interactivity and civic sense among future engineers (Johnson et al., 2011).

According to Nichols et al., 2020, CBL is a learner-centered approach that captivate students to solve real-world problems with the help of diversified stakeholders working collaboratively. Based on experiential learning theory, CBL is structured to promote active learning, multidisciplinary teamwork and reflection which is perfect for solving contemporary communities' problems (Kolb 1984). This community-centered projects with the keen involvement of students in CBL, provide opportunity to develop technical skills along with empathy, communication and understanding of societal needs (Barrett 2017).

The Community Connect course, designed for third year undergraduate engineering students adopts the CBL framework to establish social responsibility & inclusive community engagement. This is a course that is organized around projects that are collaborative, as the students work with local communities/non-profits and community members to identify and solve problems. This paper studies implementation of CBL in Community Connect course and the social responsibility element that it imparts to undergraduate engineering students. More specifically, the study explore how engagement with real-world problems helps students develop Conceive, Design, Implement, Operate (CDIO) skills to address community needs and reflect on their responsibilities as community-minded engineers.

This study contributes to the literature within engineering education on experiential learning, and provides evidence on how CBL can be sensibly embedded in the curriculum to incident with the vision underpinning education for sustainable development (UNESCO, 2017). The Community Connect course serves as a model of rethinking engineering education through experiential learning that is embedded in social responsibility, a hands-on approach tied to the evolving needs of society. The ADDIE model, a systematic instructional design framework was used to Analyse, Design, Develop, Implement and Evaluate this community connect course (Tu, Zhang, & Zhang, 2021). This methodology makes certain that the course aligns with its goal of developing social responsibility and community engagement focus for undergraduate engineering students. This work addresses CDIO standards 2, 5, 7, and 11 on Learning Outcomes, Design-Implement Experiences, Integrated Learning Experiences, and Learning Assessments. The research methodology employed to effectively implement CBL through a Community Connect Course uses a mixed-method approach, combining qualitative and quantitative research. To assess the effectiveness of the CBL implementation, quantitative research focuses on assessments of students' skills and knowledge gained during the course, while qualitative research examines reflective journals in the form of student reports, followed by oral examinations.

ANALYSIS PHASE: INSIGHTS OF GLOBAL CONTEXT, CHALLENGES AND OPPORTUNITIES

The Analysis Phase then sets the ground for the design of the Community Connect course through in-depth examination of global trends, systemic challenges and new opportunities arising from them. It is this step that involves making sure the course is useful, relevant and addresses both immediate students' needs as well as larger societal goals.

Global Context

Higher education institutions play a significant role in moulding the values, skills, and attitudes of future engineers. As the world faces systemic challenges such as natural disasters, climate change, community related issues and social inequality, there is a huge need on cultivating social responsibility and community engagement within academic curricula. The worldwide transition indicates an expanding commitment that education must go beyond disciplinary silos in order to engage the complex societal challenges and enable students to play a role in their communities — first locally, then beyond.

Across the world, higher education institutions have taken initiatives to foster social responsibility. In the United States, service-learning models are integrated with academic instruction, to impart social responsibility and reflective thinking (Bringle & Hatcher, 1996). The universities in Europe have adopted the model "third mission," which emphasizes on societal engagement integrated with teaching and research (E3M Project, 2012). National Education Policy (2020) and the University Grants Commission (UGC) of India also highlight the need of community engagement in higher education as one of the key components (Government of India, Ministry of Education, 2020). Acknowledging education as a socialisation process towards socially responsible citizens, these frameworks recommend that community-based learning should be integrated into curricula to enable the students for solving societal issues and being a part of national progress (University Grants Commission, 2019) . In Australia, universities work with communities to develop solutions to local community problems (Smith et al., 2020). These programs are designed to create culture of engagement beyond the confines of institutional framework.

Challenges

Firm Academic Programs: Engineering programs often emphasize program specific technical knowledge and skills, providing less importance to interdisciplinary/multidisciplinary courses or service-based learning. The rigid focus on technical aspects is very challenging to adopt community engagement without compromising core engineering concepts (Sheppard et al., 2009).

Dearth of Institutional Backing: Successful community engagement initiatives need resources, administrative support and faculty development. Watson et al. (2011) assert that institutions without policies or funding for such programs struggle to maintain them.

Limited Knowledge of Faculty: Most of the engineering faculty has no experience of teaching about responsibility or community-based projects. This skills gap makes it difficult to effectively execute upon engagement activities.

Views and Motivation of Students: Engineering students tend to see technical competencies over community and ethical engagement as the latter is often considered an irrelevant side-

train to their professional goals according to Bielefeldt, Paterson & Swan (2010). Changing this mindset is hard work.

Complexity of Assessment: Measuring if community engagement truly benefits students and the communities involved is hard. There are few standardized metrics to measure the intangible outcomes of empathy, civic responsibility and ethical awareness (Bringle & Hatcher 1996).

Obstacles in Logistics: Community engagement project organizing means coordinating with external stakeholder, travel management and safety and academic calendar of the institution with project lifecycle. But logistical obstacles can discourage participation.

Opportunities

Adopt Challenge-Based Learning (CBL): In engineering education, CBL provides an efficient mode for the integration and practice of community engagement. Engaging with 'real world problems' allows students to combine technical skills, with empathy and ethical reasoning (Johnson, Smith et al. 2011).

Collaborate with Industry and Non-Governmental Organizations (NGOs): Collaborating with industry and NGOs will be the backbone for community projects to have resources, expertise and the real-world relevance. These alliances enrich the depth and effectiveness of engagement initiatives (Rao & Chandran, 2020).

Use of Technology: Digital platforms and tools give students the ability to work on community ventures virtually, which increased the opportunities for engagement across great distances and logistical obstacles (Ribeiro et al., 2018).

SDGs and International Frameworks: The United Nations Sustainable Development Goals (SDGs) offer a globally recognized framework for community engagement initiatives. Projects aligned to SDGs increases visibility and the wider meaning could be seen globally (UNESCO 2017).

Interdisciplinary Partnerships: Interdisciplinary partnerships are often necessary for social responsibility efforts. Engineering students should develop as holistic problem solvers and work with peers in the medical sciences, allied health sciences, social sciences, arts and business encourages a wider range of perspectives (Smith et al. 2020).

Improved Employability Capabilities: Community projects that involve students developing critical skills (teamwork, communication and ethical decision making) are recognized as popular with employers. This can serve to empower students and induce motivation.

Social Effects and Reputation: Community Engagement initiatives that work impact society and the reputation of the institution. This double benefit inspires institutional commitment to such programs.

DESIGN PHASE: BACKWARD DESIGN APPROACH

The Understanding-by-Design (UbD) framework, a backward design approach is adopted for the Community Connect course to ensure constructive alignment between course learning outcomes, assessment strategies and instructional activities. This structured framework enhances the scope of the course to cultivate social responsibility, community engagement,

and CDIO skills among the engineering students. The following sections describes how the Community Connect course suits in to the UbD framework.

Stage 1 – Desired Results

The first stage of Understanding by Design (UbD) Framework will look into formulate the big take away or what we want our students to understand in Community Connect course designed. This stage establishes the bedrock for student learning by defining what students should know, understand, and be able do through their learning. Table 1. elaborates the first stage of the UbD process.

Table 1. First Stage – Desired Results

KEY GOALS AND OBJECTIVES • Instil social responsibility and values of ethics among students • Provide students the ability to conceive and act on real-world societal issues • Cultivate professional communication, teamwork, and technical competencies through community engagement • Encourage the students to relate theory with practical work-based application and experience
UNDERSTANDINGS *Students will understand* • the importance of engineering in addressing societal challenges • the meaning of community engagement as a step in sustainable development • the moral implications of their professional obligations
ESSENTIAL QUESTIONS *Students will keep considering* • How can engineering knowledge be applied in addressing challenges of community? • What is the place of empathy and ethics in dealing with society problems? • How do inclusive partnerships result in the delivery of sustainable solutions?
LEARNING OUTCOMES • Apply social knowledge in the real world of work and get attached to the community • Demonstrate competency in societal problems and finding solutions • Effectively implement skills in professional communication, technical writing and using multimedia tools • Develop ability to work as an individual and in a group as an effective team member • Master the professional and ethical responsibilities of a social worker

Stage 2 – Assessment Evidence

In the second stage of Understanding by Design (UbD) framework, we design assessment tools that access students' understanding, skills and knowledge. This stage guarantees that the evaluation techniques are linked with results that needed as desired in Stage 1. Through developing clear and valuable assessments, educators are able to verify that students have

attained the learning outcomes successfully. Table 2. elaborates the second stage of the UbD process.

Table 2. Second Stage – Assessment Evidence

PERFORMANCE TASKS *Students will* • Identify a community problem which may be related to any one of the following: Access and Abilities, Education and Outreach, Environment, and Human Services. • Collaborate with NGOs and Non-Profit Organizations (NPOs) working on the community problem identified. • Study the community problem with the support of the NGO/NPO • Conceive, design and develop an engineering solution for the community problem identified. • Prepare a detailed report comprising problem identification, conceptual design, project specifications and budget for the proposed community project. • Phase I assessment will include a presentation of the problem statement and proposed solution followed by oral examination evaluated by a committee. • Implement the project with the detailed design process. • Deliver and operate the project to the community and evaluate whether the project is sustainable. • Phase II assessment will include a presentation of the detailed project work followed by oral examination evaluated by a committee.
CRITERIA FOR ASSESSMENT Phase I • Engineering Design Process (20%) • Level of innovation in the project (15%) • Project alignment with the community problem (20%) • Oral examination (5%) Phase II • Deployment of the project in the community and check for sustainability (15%) • Project and financial management (10%) • Project report and presentation (10%) • Oral examination (5%)
OTHER EVIDENCE • Reflective journals of personal learning, transformation and growth • Feedback from community partners or NGOs or NPOs. • Peer feedback in terms of teamwork and collaboration

Stage 3 – Learning Plan

Understanding by Design (UbD) Stage 3 is a creation of instruction pathway to guide and support the learners in both stage 1 achieving the desired results and stage 2 doing well on assessments. Learning plan for Community Connect course ensure students are engaged in the learning and incrementally building their understanding so they attain the learning objectives through authentic/practical experiences. Table 3. elaborates the third stage of the UbD process.

Table 3. Third Stage – Learning Plan

PREPARATION PHASE:

Instructional sessions on

- Introduction to societal or community challenges, societal responsibilities, engineering ethical practices, sustainable development goals (SDGs), and the role of engineering in community development.
- Professional communication and teamwork.
- Categories of community problems, identification and analysing the problem.
- Identification of NGOs/NPOs and collaborating with them.
- Digital tools for project documentation and presentation.

COMMUNITY ENGAGEMENT PHASE:

Problem Identification and Partnership (Phase I):

- Students work individually or in groups with an NGO/NPO to figure out a community problem to solve.
- Data related to the problem is collected by conducting field visits and stakeholder interviews.

Conceive and Design (Phase I):

- Students conceive ideas for the problem identified.
- Design process with project specifications and budget are created under the supervision of the faculty mentor

Implement and Operate (Phase II):

- Students implement the project design in the institute and involve the community periodically for testing and feedback under the support of NGO/NPO.
- During operate phase, students ensure the sustainability and scalability of the proposed solution.

REPORTING AND ASSESSMENT PHASE:

Project Report Preparation:

- Students write a report of the whole project (problem analysis, project design, implementation and community engagement)
- Geotagged photos and multimedia evidence are substantiated for the demonstration of engagement.

Assessments:

- *Phase I Assessment:* Students present problem identification, NGO/NPO partnered, conceived engineering solution, design process, budget and timeline of the community engagement project.
- *Phase II Assessment:* Students deliver a final presentation elaborating the detailed project implementation and outcomes. The presentation is followed by oral examination conducted by an evaluation committee.

DEVELOPMENT PHASE

In the development phase, all resources and objects required for Community Connect course are developed for effective delivery. Key components of this include designing detailed instructional modules on societal challenges, sustainable development goals, and ethical practices. These modules also present guidelines for conducting fieldwork as well as participating with NGOs/NPOs along with technical writing tutorials and instruction on multimedia use in report writing. Templates of projects are established for problem identification, project specifications, budget proposals, reflective journals, and geotagged photo documentation. Complete evaluation rubrics have been developed that include assessment performance tasks, reports of projects, presentations, oral examinations, reflective journals, and peer feedbacks.

Online video conferencing with NGOs or NPOs is employed to tackle the logistics barrier challenge. Institute Learning Management System (LMS) is used to share the instructional materials and reports and track the progress of the project. Training and development of the faculty is conducted before the commencement of the course to prepare instructors to mentor students on community engagement, assesses intangible outcomes like empathy, and manages interdisciplinary collaborations (Rajeev & Vairavel, 2023). Also, step-by-step guidelines relating to course facilitation, assessment, and feedback mechanisms are provided in the faculty manuals.

Memorandums of Understanding (MoUs) are exchanged between the institute and NGOs/NPOs who are working on the local community issues. This MoUs help the students to collaborate effectively with stakeholders. A project selection framework is put in place to align chosen community problems with SDGs, ensuring meaningful and impactful engagements. Pilot projects are conducted before full-scale implementation to test course components, gather feedback, and refine processes. Inputs are gathered from students, faculty, and other stakeholders for clarity, usability, and relevance. In the end, all materials are finalized for delivery, including a course handbook that outlines program objectives, timelines, activities, and assessments, as well as a Community Connect Toolkit with hands-on tools and resources for students while they conduct their fieldwork and implement their projects.

IMPLEMENTATION AND EVALUATION PHASE

The Community Connect course was offered to undergraduate engineering students during their study in semester 4 and 5. A batch of 600 students, spread out over four disciplines, namely Computer Science and Engineering (CSE) with 240 students, 120 students in each of Electronics and Communication Engineering (ECE), Electrical and Electronics Engineering (EEE), and Mechanical Engineering (ME) have undergone this course in the year 2024.

During their study in semester 4, instructional sessions of duration 15 hours were conducted to impart societal or community challenges, societal responsibilities, engineering ethical practices, sustainable development goals (SDGs), and the role of engineering in community development, professional communication and teamwork, categories of community problems, identification and analyzing the problem, identification of NGOs/NPOs and collaborating with them, digital tools for project documentation and presentation. After the preparation phase, students were grouped into teams of 4–5 members, comprising members from CSE, ECE, EEE, and ME ensuring interdisciplinary participation and obtain diverse perspectives for the community problem identified. During summer vacation, student teams had partnered with NGOs/NPOs to figure out a community problem to solve and collected data related to the

problem by conducting field visits and stakeholder interviews. At the start of the semester 5, student teams were assessed with their submitted report on problem identification and proposed engineering solution by the evaluation committee. After phase I of assessment, the teams have started progressing towards the design, implement and operate parts of the project which were carried out in the institute project space. The similar exercise was given as an experience during their first year of study in the course Philosophy of Engineering but with less complexity (Vairavel & Rajeev, 2024) During the project work, the teams were instructed to collaborate with the community in the weekends for testing and evaluation and get constructive feedback for necessary improvements. After successful implementation and delivery of the project to the community, the students' knowledge and skills acquired during community engagement were assessed at the end of the semester 5 using assessment rubrics.

Totally 115 community engagement projects were successfully completed by the students in the year 2024 as a part of Community Connect Course. Out of 115 projects, 66 are based on access and abilities, 9 based on education and outreach, 21 based on environment and 19 based on human services. The projects have addressed SDGs such as SDG 3 – Good Health and Well Being, SDG 4 – Quality Education, SDG 6 – Clean Water and Sanitation, SDG 7 – Affordable and Clean Energy, SDG 14 – Life Below Water, SDG 16 – Life on Land and SDG 17 – Partnership for the Goals. The summary of the community engagement projects and feedback given by the students about the course is shown in Figure 1. The analysis shows that about 75 percent of the students could conceive ideas for the societal problems through handholding and only 17 percent could solve independently without guidance. Above 70 percent have given excellent for assessment and evaluation methods used which will be improved in the year 2025. The students have expressed that this kind of real-world problem solving through community engagement makes them to feel as an engineer during their period of study. The course has significantly enhanced their knowledge on social responsibilities, professional communication, problem solving, critical thinking and CDIO skill.

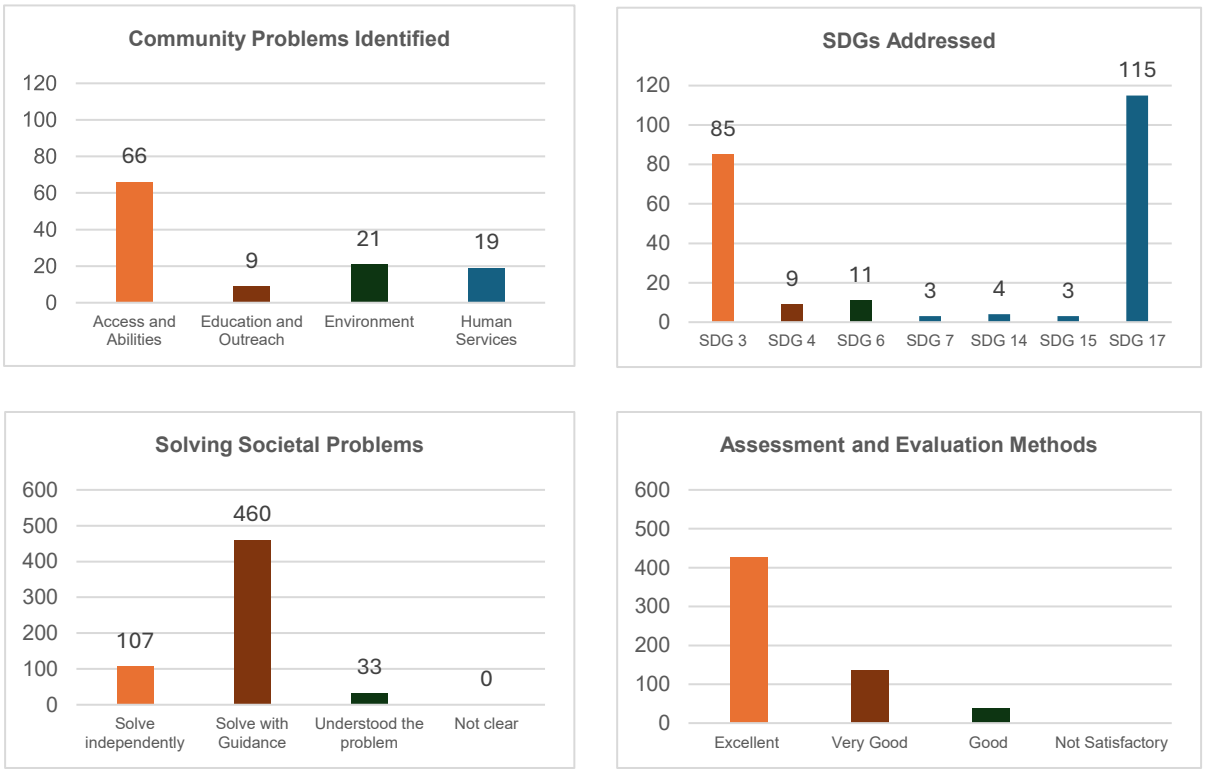

Figure 1. Community Engagement and Feedback Analysis

Impact

The application of Challenge-Based Learning (CBL) via the Community Connect Course has had a considerable positive influence on students as well as the community. NGOs have increasingly accessed the course, posing more varied real-world problems, resulting in signing more Memorandums of Understanding (MoUs). Through such collaboration, students have become better connected with the community as they work on actual challenges relevant to the needs of the community.

Consequently, the community has contributed more intricate problems, which not only improved students' problem-solving skills but also generated innovative ideas. The ability to solve real-world problems has allowed students to think critically and come up with creative solutions that can potentially benefit the community.

The CBL methodology has also allowed for increased interaction between students from different years. Increased numbers of juniors have begun interacting with seniors, developing a peer mentoring culture. This sharing of information and experiences has helped develop social competencies, whereby students learn essential skills in teamwork, communication, and leadership.

Furthermore, the students have developed considerable personal and professional development in their portfolios. The experience in community-based projects has increased their sense of social responsibility and enhanced their ability to solve problems associated with society. Generally, the application of CBL has not only helped the students in academic terms but has also instilled a stronger community attachment, shaping well-rounded students equipped to deal with actual challenges.

Limitations

Following are some limitations experienced during the implementation of Challenge-Based Learning (CBL) through the Community Connect Course:

Limited Range of Community Issues: While NGOs are reporting more problems, the extent of challenges covered are constrained by the scope or emphasis of the organizations, which did not address all issues of concern in the community.

Time Limitations: Tackling community issues had demanded extensive time allocation. Students slightly found it difficult to coordinate these projects with their studies.

Uncertainty in Measuring Long-Term Effect: The long-term effect of the solutions devised by the students is still hard to measure, and need extended intervention longer than the course period.

Implementation Barriers: Even when students developed excellent ideas, the implementation of solutions in the community was constrained by administrative, legal, and logistical issues, requiring several processes for effective execution.

CONCLUSION

The Community Connect course is a model of best practices for embedding social responsibility and community engagement in engineering education. Integrating the challenge-based learning approach and CDIO guidelines, the course connects technical

competence with civic responsibility. The ADDIE model based systematic implementation ensured that the course achieved all its objectives for an ethical awareness as well as teamwork and critical problem-solving among the students.

In 2024, the 115 projects that were completed by 600 students covered a wide range of social challenges and thus were through positive impact on the communities while they were in alignment with the several sustainable development goals. Through a holistic approach and collaboration with NGO and NPO professionals, students took the role of community developers that were concerned with the long-term impact and the environmental wellbeing. Results of assessment showed tremendous improvement in students' social awareness, technical skills, and professional communication skills. "Community Connect" is a course that explicitly imparts the skills of knowledge application and ethical conduct within a broader understanding about changing engineering education.

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