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Engineering Faculty as Co-Learners in Service-Learning: Building Empathy, Design Thinking, and Leadership Skills through Community Engagement

Surendra Bandi*
Hyderabad Institute of Technology and Management
Hyderabad, India

Ashok Shettar
KLE Technological University
Hubballi, India

Gopalkrishna Joshi
MIT Vishwaprayag University
Solapur, India

Rohit Kandakatla
KG Reddy College of Engineering and Technology
Hyderabad, India

Abstract. Service-learning is a teaching and learning approach that combines community service with academic learning and has been gaining traction in Indian engineering education. While traditional teaching methods have limitations in extending learning beyond classrooms, service-learning has the potential to ensure meaningful student engagement in addressing real-world problems effectively. Community, students, and faculty are considered to be key stakeholders in the process, with each playing an important role in ensuring the success of service-learning programs. Although significant research has been conducted on the role and impact of service-learning on communities and students, the impact on faculty remains largely unknown. Understanding the role of faculty learning within service-learning is important because it equips faculty with the skills and insights necessary to facilitate community engagement activities and ensure a richer educational experience for students. Therefore, this study delves into the dynamics of faculty learning within service-learning courses, focusing on an undergraduate engineering

* Corresponding author: *Surendra Bandi, surendra.mca@hitam.org*

program at a private technological university in Southern India. The research centers on exploring the ways in which faculty perceive their own learning while facilitating service-learning courses. A qualitative approach was adopted, and data were collected through 20 interviews of engineering faculty members in India. The findings reveal the significant impact of service-learning on faculty as it enhances their teaching and learning competencies, societal empathy and design thinking skills. Also, service-learning experiences helped faculty members to transform into community leaders who were facilitating and driving change in partner communities. The study highlights the need for institutional recognition and support for faculty engaged in service-learning. The study contributes to the expanding experiences of service-learning in India, highlighting its role in enhancing faculty learning and community engagement.

Keywords: community engagement; faculty learning; Indian higher education; service-learning

1. Introduction

As the fifth industrial revolution is bringing us into an era of human-centered technology and societal impact-focused innovation, the need arises for an education system that engages with the community (Ziatdinov et al., 2024). This emerging requirement reflects the growing calls for socially responsible education which emphasizes human-centered technological advancements and a focus on the societal impact of innovation (Coelho et al., 2023). Announced in 2020, India's National Education Policy also emphasized the need to reimagine higher education, making it more relevant to society (Kandakatla et al., 2024). Service-learning provides opportunities for higher education institutions to integrate academic learning with community service (Oakes et al., 2025), thereby rendering it an appropriate tool with which to prepare for the fifth industrial revolution (Santosh et al., 2024). Particularly in engineering, service-learning offers students the opportunities to apply their technical and innovation skills to solve real-world problems (Penta et al., 2024). However, the success of service-learning programs necessitates effective coordination and planning from all three key stakeholders: community members, students, and faculty. Faculty members are considered to be central to this process of implementing service-learning as they are responsible for the design and implementation of the program, for building meaningful partnerships with community organizations, and for ensuring both the academic and community engagement components of service-learning are properly integrated in order to create mutually beneficial experiences for both students and community stakeholders (Borkoski & Prosser, 2020).

Despite the growing prevalence of service-learning in education, the focus of existing research has largely been on its impact on students, communities and institutions. To date, the critical role of faculty in service-learning initiatives has been overlooked. Studies have documented the benefits of service-learning for students, such as enhanced problem-solving skills, social responsibility, and civic engagement. However, much less attention has been paid to its impact on faculty learning. Although some studies have examined faculty motivation to engage in service-learning (Surendra et al., 2024), the impact of service-learning on faculty

learning remains underexplored (Bandi et al., 2023). Addressing this gap is important because faculty members themselves undergo significant professional and personal development through their engagement with service-learning. Each service-learning experience offers a unique context that can provide new learning experiences to both students and faculty. Therefore, the extent of faculty learning during service-learning in the engineering education context remains an area that has not yet been adequately studied and reported.

This study seeks to explore the learning experiences of faculty members involved in service-learning courses within undergraduate engineering programs at a private technological university in India. It aims to answer the following research questions:

1. How do faculty members perceive their role as co-learners in service-learning experiences?
2. How does engagement in service-learning impact faculty learning?

A qualitative case-study approach was employed to investigate faculty members' perceptions of their own learning and development when engaging in service-learning. Semi-structured interviews were conducted with 20 engineering faculty members in India and the collected data were analyzed through thematic analysis. By investigating faculty learning, this research contributes to understanding the dynamics of service-learning and highlights the importance of supporting faculty members in these efforts. Furthermore, this study seeks to provide insights for engineering educators and institutional leaders, highlighting the need to recognize and support faculty development in service-learning contexts.

2. Literature Review

Articles that highlight service-learning as an emerging educational model in education are reviewed in this section. This review includes the experiences of engineering institutions that have implemented service-learning courses in their curricula. Various case studies exploring the effect of service-learning on faculty learning and development are discussed.

2.1 Service-Learning

Several definitions exist in the literature for service-learning. This study follows the definition provided by Bringle and Hatcher (1996) as it is comprehensive and encompasses a well-rounded, impactful and academically integrated approach:

> "*Service learning is a credit-bearing educational experience in which students participate in an organized service activity that meets identified community needs and reflect on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility.*" (Bringle & Hatcher, 1996)

Nevertheless, it is important to explore more deeply the components of service-learning, which are service, academic learning, reciprocity, and reflection. Each of these components plays a vital role in the overall impact of service-learning. Service refers to the activities performed by students that meet the needs of the community. According to Eyler and Giles (1999), effective service-learning involves

students engaging in meaningful service that is coordinated with the community and educational institutions. Moreover, service activities should be structured in such a way as to align with the academic goals of the course as well as the personal growth of the students. In the context of service-learning, academic learning refers to the integration of service activities with academic content. This ensures that students connect their service experiences with their coursework, thereby deepening their subject matter expertise. Reciprocity is a fundamental principle of service-learning, emphasizing mutual benefit and respect among students and the community (Delaine et al., 2023). As described by Howard (2001), reciprocity ensures that the service activities are not a one-way transaction but a collaborative partnership in which both the students and the community members learn and benefit from each other. As the final component, reflection is the process by which students critically analyze their service experiences, connecting them to academic content (Dustker et al., 2021). Eyler (2002) asserts that reflection is a component of service-learning that allows students to gain insights, question assumptions and understand their roles as active citizens.

Service-learning was first introduced in the field of education within teacher education programs. Early advocates such as Stanton et al., influenced by such educational theorists as John Dewey, emphasized combining experiential learning with community service to enhance civic responsibility and social engagement among students (Stanton & Giles, 2017). Later, the use of service-learning was expanded to the fields of social sciences, arts and humanities, health sciences, medicine, business management, and engineering, as reported by Coyle et al. (2006). Service-learning in engineering is explored in the next section.

2.2 Service-Learning in Engineering Education

Engineering is about problem-solving; thus, service-learning projects often involve real-world challenges that require innovative and practical solutions. By participating in these projects, engineering students can apply theoretical knowledge, develop critical thinking, and learn through experience. Oakes et al. (2014) provided an overview of various models of service-learning in engineering, highlighting successful implementations and the benefits these programs offer. One early example of the service-learning concept being implemented in engineering programs was provided by EPICS (Engineering Projects in Community Service), in which students worked with community members who needed technical assistance. Subsequently, EPICS has been introduced in various institutions around the globe. Bielefeldt and Canney (2014) highlight other service-learning programs in engineering. A resource book edited by Tsang (2000) provides guidance on models for integrating service-learning into engineering education. It addresses the needs of the engineering profession and offers guidance for implementing service-learning projects that matter, both academically and socially. Similarly, other organizations have integrated engineering applications with addressing community needs.

Adding service-learning projects into engineering curricula offers significant benefits for students, including improved attitudes, enhanced teamwork skills, and a broader understanding of their roles as engineers in society. Oakes et al. (2002)

emphasize the potential of service-learning to fulfill many criteria of the Accreditation Board of Engineering and Technology (ABET), which traditional engineering courses might struggle to meet. The authors posit that service-learning can also influence underrepresented groups to pursue engineering by contextualizing the work within community-based projects. One example reported by Kandakatla et al. (2023) describes how the service-learning experiences help students in achieving the graduate attributes specified by the NBA (National Board of Accreditation) in India.

The last decade witnessed the significant adoption of service-learning among engineering institutions in India. For example, Unnat Bharat Abhiyan (UBA) is a flagship program initiated by the Ministry of Education, Government of India, aimed at connecting education institutions and villages in India to address the developmental challenges of rural areas through innovative and sustainable solutions (Bandi & Naik, 2020). Research on the UBA program reported that students who visited the partner villages were able to empathize with community members and identify unmet needs that need to be addressed in order to allow for socio-economic development (Kandakatla et al., 2022). This initiative enables engineering faculty and students to work with communities and apply their academic knowledge to community-based problems, bringing a collaborative relationship between academic institutions and local communities (Radhakrishnan et al., 2022).

The context of this research study is in a technological private university in India, which integrated service-learning into its curriculum through its innovative two-credit "Social Innovation" course for first-year students (Shinge et al., 2021). Based on the Human-Centered Design approach, this course integrates experiential learning and community engagement, allowing students to identify and work on social issues through creative problem-solving and sustainable solutions. In contrast to engineering internships, which typically focus on providing students with practical industry experience and prioritize the needs of the company, service-learning integrates academic learning with community service, aiming to address real-world problems while enhancing students' social responsibility and civic engagement.

2.3 Faculty as Key Stakeholders in Service-Learning

Faculty members play an important role in designing and implementing service-learning, extending far beyond traditional teaching responsibilities. As the primary facilitators of service-learning, they serve as the "glue" that holds together the various elements of the initiative, bridging the gaps between students, the institution, and the community. Their engagement is multifaceted, involving curriculum development, building community partnerships, mentoring students, and integrating service-learning into the academic framework (Radhakrishnan et al., 2022). Faculty bring their unique perspectives and expertise to the design and delivery of service-learning courses.

O'Meara and Niehaus explored the discourses among faculty regarding service-learning, highlighting the complexity of motivations and institutional integration.

They identified the following four primary frameworks through which faculty engage with service-learning: as an innovative teaching model; as a deeply personal practice tied to individual identity; as an expression of institutional mission; and as a form of active community partnership (O'Meara & Niehaus, 2009). Their analysis implies that these varied perspectives significantly influence the way in which service-learning is implemented and perceived in academic settings, offering insights into both the potential of the scheme and the faculty's challenges of embedding service-learning in the curriculum. Berkey et al. present the development practices related to faculty development in community engagement, offering examples, models, and strategies to evolve faculty development efforts in service-learning and community engagement on their campuses (Bergen, 2020).

Several studies have reported the benefits of service-learning to students, communities and institutions. However, little research to date has analyzed educators' learning and development in service-learning contexts. Research from Camus et al. (2022), focusing on the impacts of service-learning on faculty, reveals both positive and negative experiences among educators across diverse disciplines. Findings demonstrate that service-learning not only enhances faculty teaching and civic-mindedness but also contributes significantly to personal values, professional development, and research opportunities (Camus et al., 2022).

Existing research indicates the targeted support and recognition of faculty efforts in service-learning contexts, emphasizing the need to balance the challenges with substantial personal and professional rewards. However, Bandi et al. reported that while significant research has analyzed the roles of students, community, and institutions in service-learning, less focus has been placed on faculty learning. Their study highlights the gap in the literature regarding the importance of faculty as co-learners (Faculty collaborating with students and learning while teaching) , which is crucial for the implementation of service-learning courses for undergraduate engineering students (Bandi et al., 2023). While service-learning has gained traction as an effective educational approach, there remains a significant gap in the research, particularly in terms of studies dedicated to the support and development of faculty members who are engaged in service-learning. Therefore, focused studies are needed to better understand the role of faculty in service-learning, ensuring its successful integration and sustainability.

The literature on service-learning highlights its capacity to enhance educational outcomes, meet accreditation criteria, and address social issues. Faculty members play a significant role in this educational approach; indeed, their development and support are vital for the successful implementation and sustainability of service-learning programs. Due to the notable potential benefits of these programs, more research on faculty learning is needed in service-learning contexts to ensure that both faculty members and students benefit from these opportunities. Hence, the current study seeks to address this gap.

3. Methodology

3.1 Research Context

This study seeks to explore the role of faculty learning in service-learning within the context of an Indian institution. It is a private university located in a Tier 2 city in southern India. The institution offers a course on "Design Thinking and Social Innovation" (DTSI), in which students are expected to visit local communities, empathize and understand their problems and design interventions to address these issues using concepts taught in the course. The DTSI course serves as the context for this research. The study investigates the experiences of faculty members who facilitate the DTSI course, aiming to explore the ways in which they engage in co-learning with stakeholders.

The DTSI course is a foundational course introduced to all first-year undergraduate engineering students during their second semester. The course is structured around introducing students to complex societal problems and encouraging them to develop innovative solutions through a design thinking approach. The course content revolves around real-world challenges, whereby students work closely with community stakeholders to identify challenging social issues. In so doing, the students develop a deep understanding of the needs and concerns of those they aim to help. The course guides students through the five phases of design thinking—Empathize, Define, Ideate, Prototype and Test—all of which enable them to apply their academic knowledge in solving problems that have real-world significance. Therefore, this constitutes a service-learning course as it involves academic credits and creates opportunities for students to apply academic learning to real-time problems while providing meaningful service to the community.

Assessment in the course is both formative and summative, ensuring that students' progress is measured continuously and holistically. Students work in teams to visit the community, define problem statements, and develop solutions while being assessed on their ability to apply the design thinking process. Key assessment criteria include the effectiveness of their empathy-driven research, the innovativeness of their ideas, the feasibility and impact of their prototypes and their overall engagement with community stakeholders. The final assessment often involves an exhibition or presentation, in which teams showcase their solutions and reflect on the design process. The course is facilitated by multiple faculty members simultaneously in a studio setting, where the teams have access to various engineering tools. Faculty members play the role of facilitators rather than traditional instructors, guiding students in their explorations and helping them to navigate the complexities of real-world problem-solving. Peer collaboration is a key aspect of the learning process, with students working in diverse, multidisciplinary teams to develop a holistic perspective on the issues they seek to tackle.

3.2. Research Approach

This study employed a qualitative case-study approach to explore the ways in which faculty members engage in their own learning while facilitating the DTSI course. The case-study approach was deemed appropriate for this research as it allows for an in-depth exploration of a specific educational program within a real-world context. Situated within an Indian institution, the DTSI course serves as a

representative case of service-learning in engineering education in India. This adds to the limited literature on service-learning programs in the Indian context. Using a qualitative case-study methodology allows for examining the complex and context-specific nature of faculty learning in the service-learning environment. Moreover, the case-study approach provides a framework for capturing the real-world interactions and experiences of faculty members as they navigate the co-learning process with students and community stakeholders. Furthermore, it serves to explore how institutional and cultural factors influence the faculty's teaching and learning experiences. The selection of a qualitative framework is based on the guidelines provided by Merriam and Tisdell (2015), who emphasize understanding the meaning that participants make out of their experiences through detailed, narrative descriptions. Creswell and Creswell's (2018) guidelines advocate for a systematic approach to qualitative research, including the use of multiple data sources, an iterative process of data collection and analysis and an emphasis on the researcher's reflexivity. Both sets of guidelines stress the value of using qualitative methods for gaining a deeper understanding of participants' experiences, which is crucial for our study of faculty learning in service-learning contexts.

3.3 Participant Recruitment Strategy

The participants of this study are the faculty members who facilitated the DTSI course for first-year engineering students. The selection of participants for the research study was undertaken according to the following criteria:

a) Experience in facilitating service-learning courses: Those with experience in facilitating these courses were included, thereby ensuring the insights are deeply rooted in actual teaching experiences.
b) Extent of prior teaching experience: Participants range from novices to experienced educators to cover a spectrum of experiences and perspectives.
c) Diversity in engineering discipline: Faculty members from various engineering disciplines were included, thereby enriching the study by examining the variances in motivations across different specializations.

The final sample consisted of 20 faculty members, whose experience ranged from three to 21 years. Interviews were concluded once the data saturation point was observed. The diversity in various categories, as specified in Table 1, allowed for a comprehensive examination of the ways in which faculty members, regardless of their tenure, approach and reflect on their teaching practices within the service-learning framework. Participants were selected from various disciplines, providing a broad perspective on the interdisciplinary application of service-learning in engineering education. Focusing on these criteria ensured that the faculty members selected for the study could provide comprehensive insights into faculty learning in service-learning. IRB (Institutional Review Board) approval was obtained to conduct interviews with these individuals.

Table 1: Participant demographics

Participant	Gender	ID	Department	Experience
P1	Male	B12	Engineering Science and Humanities	14 years
P2	Male	B14	Engineering Science and Humanities	9 years
P3	Female	B9	Civil Engineering	8 years
P4	Female	B10	Civil Engineering	4 years
P5	Male	B8	Civil Engineering	3 years
P6	Female	B11	Electronics & Communication Engineering	14 years
P7	Male	B4	Mechanical Engineering	21 years
P8	Male	B2	Mechanical Engineering	8 years
P9	Male	B7	Mechanical Engineering	9 years
P10	Male	B6	Mechanical Engineering	12 years
P11	Male	B3	Mechanical Engineering	20 years
P12	Male	B1	Mechanical Engineering	14 years
P13	Male	B5	Mechanical Engineering	14 years
P14	Male	B13	Business Management	18 years
P15	Male	H2	Business Management	14 years
P16	Female	H4	Engineering Science and Humanities	15 years
P17	Female	H3	Electronics & Communication Engineering	9 years
P18	Male	H1	Mechanical Engineering	13 years
P19	Male	HP2	Mechatronics	4 years
P20	Male	HP1	Industrial Engineering	4 years

3.4 Data Collection and Analysis

The focus of data collection was on faculty members who were actively involved in service-learning. Data collection was undertaken through semi-structured interviews. An interview protocol (Appendix A) was designed to ensure the questions were designed to adequately prompt the participants to gather the needed data. Beginning with demographic and educational background queries, the interviews progressed to include deeper motivational questions. Preliminary pilot interviews were conducted with two participants to refine the questions, ensuring they were open-ended and unbiased. Interviews were recorded and transcribed using the Microsoft 365 app. Transcripts were first cleaned to eliminate any superfluous language. A thematic analysis was performed to identify patterns and construct aspects that answer our central research question. Thematic analysis is deemed appropriate for identifying, analyzing and reporting patterns within qualitative data. This method allows for a rich and detailed account of the data, making it particularly relevant for the present study, which aims to understand the multifaceted experiences of faculty members involved in service-learning. Thus, we conducted thematic coding of the interview transcripts. Two researchers independently reviewed a subset of transcripts to identify repeating patterns. A draft codebook was developed and refined iteratively. Discrepancies in coding were resolved through consensus.

3.5 Study's Trustworthiness and Reliability and Researcher's Positionality

The validity of our data collection instrument was confirmed through initial cognitive interviews conducted with other engineering faculty members. Feedback from the cognitive interviews was used to make appropriate changes to the semi-structured interview. Thematic analysis was conducted by two researchers who independently coded the transcripts to identify repeating patterns and themes. These researchers met regularly to review their results and check for inter-rater reliability. Discrepancies in the results were resolved through discussion and consensus. The study's findings are discussed in relation to the existing literature on faculty motivation for engaging in academic service-learning, ensuring a rigorous comparison and validation of the results. This research was conducted by the primary author, who is a teaching faculty member in an undergraduate engineering college in India. With over ten years of experience in supporting faculty members in service-learning courses, the primary author's rural background gives rise to a particular commitment to community engagement in education. Furthermore, the study's co-authors, who have expertise in engineering education, administration and service-learning, enrich the research process by contributing their diverse perspectives. Together, we recognize the importance of reflexivity in understanding how our individual positionalities may influence the research outcomes. Therefore, we are committed to critically examining our roles throughout the research process.

4. Results

Data analysis results are presented in this section, which is structured as follows: participating faculty members' perceptions of their learning; faculty members' development of empathy; and faculty members' roles. Within each theme, sub-categories arising from the thematic analysis are reported, along with exemplification, in Table 2 below.

Table 2: Summary of results

Theme 1: Development of teaching competencies through service-learning
Sub-theme 1.1: Improved teaching competencies due to real-world engagement through service-learning
Sub-theme 1.2: Strengthened student-faculty relationships through mentorship roles in service-learning
Sub-theme 1.3: Enriched multidisciplinary teaching from collaborative service-learning experiences
Sub-theme 1.4: Effective bridging of theoretical knowledge and practical application in engineering through service-learning
Theme 2: Broadened societal empathy among faculty members
Sub-theme 2.1: Deepened empathetic insights gained from faculty-community interactions in service-learning
Sub-theme 2.2: Personal and professional development inculcated by service-learning practices
Sub-theme 2.3: Broader societal awareness and insights achieved through service-learning engagement

Theme 3: Transformation in faculty identity as innovator and leader
Sub-theme 3.1: Enhanced faculty competencies through problem-solving using design thinking in service-learning
Sub-theme 3.2: Application of design thinking to address complex, multidisciplinary problems beyond technical areas
Sub-theme 3.3: Gaining a deeper understanding of community issues through conducting insightful stakeholder interviews in service-learning

4.1 Theme 1:- Development of Teaching Competencies through Service-Learning

During the interviews, participating faculty members reflected on their own learning and development; these reflections are categorized into four sub-themes. The sub-themes explore how engagement in service-learning programs contributed to the enhancement of teaching and learning skills among faculty members.

4.1.1 *Sub-theme 1.1: Improved teaching competencies due to real-world engagement through service-learning, leading to practical skill development and application*

Participants (N=20) indicated that their involvement in service-learning initiatives improved their teaching competencies. According to them, these initiatives allowed them to incorporate real-world problems into their teaching practice, leading to a deeper connection between theoretical knowledge and its application. One participant reflected:

> *"Service-learning has been great and valuable in expanding my knowledge. I now feel more confident in teaching various subjects and incorporating service-learning into them effectively."* (Participant B13)

This statement highlights the way in which service-learning has broadened the participant's teaching horizon, enabling them to apply service-learning strategies across different subjects. Another participant shared a specific example of how service-learning enhanced their problem-solving skills during a faculty development program. They described their experience of visiting a technical industry and working on a problem related to a machining process, stating:

> *"This was possible only because of the service-learning course, and my confidence increased further for any other such project."* (Participant B2)

Thus, the responses indicate that service-learning equips faculty members with the confidence and practical skills necessary to tackle real-world issues. This also improved their overall professional experience.

4.1.2 *Sub-theme 1.2: Strengthened student-faculty relationships through mentorship roles in service-learning, resulting in more collaborative learning environments*

Another significant aspect of service-learning is the enhanced relationships that result between faculty and students through mentorship roles. Participants noted that the time spent with students during community visits and projects helped

them to better understand student behaviors and the dynamics of teams. As one participant explained:

> *"Certainly, the time we spend with students during community visits and while doing their projects helps us in knowing the student behavior and the working styles of the teams."* (Participant H1)

This statement emphasizes the role of service-learning in creating opportunities for faculty to observe and engage with students outside of traditional classroom settings, which also enhances their mentorship capabilities. Furthermore, the participants also highlighted the mutual learning process facilitated by mentorship.

> *"We also learn many more things when we start working with the students and mentoring them. Once we started being with them and mingling, we came to know their insights."* (Participant B12)

This reveals that faculty members gain insights into personalized learning because of their close involvement with students during service-learning activities. Faculty members reported seeing improvements in their own communication and engagement skills as a result of the programs. This contributed to more effective and meaningful mentorship experiences (Participant B8). The mentorship roles in service-learning enable faculty members to foster a more collaborative and supportive learning environment, which benefits both faculty and students.

4.1.3 *Sub-theme 1.3: Enriched multidisciplinary teaching from collaborative service-learning experiences, facilitating comprehensive educational approaches*

Faculty members highlighted how service-learning promoted multidisciplinary collaboration. For example, one participant noted:

> *"When I teach other subjects, my knowledge is usually limited to the content within a specific boundary. But with service-learning, the experience goes beyond that. It extends my understanding and involves real-world applications. It made the learning process more meaningful and ongoing."* (Participant H2)

This response reflects the way in which service-learning pushes faculty members beyond their traditional disciplinary boundaries.

Half of the participants mentioned that faculty members from different engineering disciplines faced challenges while working on multidisciplinary service-learning projects. For example, one participant stated:

> *"[It] was a bit difficult for people from the CS(Computer Science) department to understand the engineering mechanics related to the models built for the community, and then when it comes to programming, we faced difficulties since we are from mechanical engineering."* (Participant HP2)

However, the same participant noted that over time, both faculty members and students were able to learn from each other, resulting in improved learning:

> *"These days, I am helping students with programming after I learnt it from the CS faculty and from the students when working on the projects."* (Participant HP2)

This highlights the service-learning's role in providing an experience in which faculty members become learners as well as educators. By integrating multidisciplinary approaches, the teaching landscape is enriched.

4.1.4 *Sub-theme 1.4: Effective bridging of theoretical knowledge and practical application in engineering through service-learning, enhancing practical understanding*

Service-learning was seen by faculty members as being an effective method to connect theoretical concepts and real-world applications. Participants explained that service-learning has enabled them to design activities that apply theoretical concepts to the tasks they undertake with the students on identified community issues.

> *"It has helped in designing the activities for the courses in which [the] application of concepts [to] the real problem is possible."* (Participant H3)

This demonstrates the way in which service-learning allows faculty members to create a learning environment that connects academic theories with practical and first-hand experience. Consequently, this results in improved learning outcomes for students. Another participant elaborated on the challenges of completing service-learning projects within a limited academic timeframe but emphasized that such challenges also created opportunities for future students to continue the work.

> *"Sometimes, we don't take up the problems which take a very long time, like one year and more than that. But we allow the next batches to continue if we find any suitable students."* (Participant B4)

Not only does this iterative approach reinforce the application of theoretical knowledge, but it also encourages a continuous learning process that extends beyond a single academic term. Service-learning motivates faculty members to document their experiences and share insights with their peers. It also promotes a scholarly approach to integrating practical applications into education. These findings suggest that service-learning serves as a catalyst for enhancing educational outcomes and promotes faculty development in engineering education. Through service-learning, faculty members can refine their teaching methods.

4.2 Theme 2: Broadened Societal Empathy among Faculty Members

The sub-themes illustrate the ways in which faculty-community interactions and socially relevant projects result in a deeper understanding of societal issues, which in turn motivates faculty members to engage meaningfully in addressing real-world challenges with empathy.

4.2.1 *Sub-theme 2.1: Deepened empathetic insights gained from faculty-community interactions in service-learning, promoting awareness and sensitivity*

The first sub-theme highlights the ways in which direct engagement with communities during service-learning experiences enhances faculty members' awareness of societal issues. Additionally, this also prompts them to adopt empathetic and compassionate approaches. Faculty members who may previously have had limited exposure to certain societal contexts initially found it difficult to

understand people's issues. Thus, this contact expanded their understanding of social realities that had been overlooked within traditional academic settings.

For instance, Participant B12 reflected on the way in which service-learning helped in creating awareness of societal dimensions, particularly the indifference of certain privileged groups towards needy.

> *"We understood many situations which take place in our society where we are part of. How do people express themselves to others when there are incidents? At times I notice that people who are well educated with higher qualifications also do not feel concern about the needy in the community. I feel we need to know many aspects of society. Courses like DTSI have scope to achieve this."* (Participant B12)

Such interaction with the community helped to develop empathy, as faculty members began to see the issues through the lens of lived experiences. Thus, faculty members had to extend their roles as educators to become socially conscious innovators. Similarly, Participant B2 mentioned the way in which the process of preparing students for community visits nurtured empathy, both in students and faculty members. Thus, the traditional educator-student relationship translated into mutual empathy.

> *"I didn't observe empathy in the past before this course though I was concerned about people and the worries. As we needed to make students think from the user's point of view, even I started to feel it when I was discussing with the students before, during and after the community visits."* (Participant B2)

These insights demonstrate a key argument: service-learning provides an essential pedagogical framework that integrates real-world contexts into educational practices. Within such a framework, faculty members are encouraged to develop greater sensitivity towards social issues. Their expanded empathy, in turn, reshapes their approach to teaching, emphasizing the need for compassion. This is increasingly being recognized as essential for holistic education in modern society.

4.2.2 *Sub-theme 2.2: Personal and professional development inculcated by service-learning practices, leading to holistic growth in faculty*

The second sub-theme explores the significant personal and professional growth that faculty members experience through service-learning. Participants described the way in which service-learning serves as a process of continuous learning, with each interaction contributing to their development as both educators and individuals. Participant H2 referred to the "accumulation of knowledge and experience" gained through repeated service-learning engagements, which strengthens their ability to guide students in navigating complex real-world problems.

> *"Anything I learnt from one batch of students, I was able to apply it on the next set of students in the next batch. There was always improvement in the way that I was able to deal with the newer batches of students. I was also able to help students [learn] how to be stronger as per the situations in their future careers and personal life as well."* (Participant H2)

This continual growth is reflective of a learning cycle in which faculty members impart knowledge and are transformed by the experiences they facilitate. As faculty members interact with various students and community stakeholders, they become more confident at mentoring and student engagement. Service-learning catalyzes holistic development, whereby faculty members are not only educators but also lifelong learners. Thus, they expand their technical and academic skills and gain personal insight into the human and societal dimensions of their work.

4.2.3 *Sub-theme 2.3: Broader societal awareness and insights achieved through service-learning engagement, enhancing faculty's societal contributions*

The third sub-theme emphasizes the expanded societal awareness that service-learning fosters among faculty. It reveals how faculty members gain a broader perspective on societal challenges and the critical role they play in addressing them. By stepping outside of their academic disciplines, faculty members are able to recognize their potential to contribute to larger societal causes, particularly through their engineering expertise. As Participant H2 asserts, engineers are creators with a responsibility to address societal problems.

> "*Being engineers, we have a unique responsibility for the society. Science brings principles and engineers design products using those principles which can provide solutions to the pain points of the society.*" (Participant H2)

This recognition leads faculty members to view societal issues as being central to their professional responsibilities, rather than believing them to be estranged from academia. Similarly, Participant B5 highlighted the fact that traditional courses rarely address the social difficulties individuals face, noting it as a gap that service-learning bridges.

> "*The regular courses have very limited possibilities of incorporating contexts related to community engagement. Those are generally around conceptual knowledge. Most of us do not know what happens with many people around us. We will be shocked to see those when we go for immersion activities.*" (Participant B5)

Exposure to societal challenges during service-learning allows faculty members to see "a different picture" beyond their academic ivory towers, leading them to adopt a more socially responsible approach in both their teaching and their research. The sub-theme illustrates that service-learning builds empathy among the faculty members and fosters proactive attitudes towards societal contributions. Faculty members become more attuned to the complexities of human life and are more inspired to contribute to social improvement. This new sense of societal awareness expands their role beyond traditional academia.

The findings confirm the role that service-learning plays in reshaping faculty members' perspectives and responsibilities. As a result of service-learning, faculty members become more empathetic educators and develop a broader societal consciousness. The combination of personal growth, professional development, and heightened societal responsibility highlights the transformative potential of service-learning.

4.3 Theme 3: Transformation in Faculty Identity as Innovator and Leader

The following sub-themes explore the transformative roles faculty members adopt through service-learning, whereby they expand their traditional academic duties to take on the roles of innovators, problem-solvers and changemakers. Service-learning extends beyond conventional pedagogical practices, enabling faculty members to actively engage in solving real-world problems alongside their students. By utilizing design thinking methodologies and empathetic engagement with communities, faculty members are able to broaden their competencies and develop practical solutions that create impact both within and outside the academic environment. The sub-themes capture the essence of faculty-led innovation, positioning the faculty members as important players in the co-creation of knowledge and the cultivation of solutions that benefit society.

4.3.1 *Sub-theme 3.1: Enhanced faculty competencies through problem-solving using design thinking in service-learning, leading to innovative teaching practices*

This sub-theme focuses on the way in which faculty members harnessed design thinking as a structured and flexible approach to problem-solving within service-learning environments, thereby enhancing their overall teaching practices. Design thinking encourages a human-centered approach to identifying and solving problems. In traditional academic settings, faculty members confine their teaching to course syllabi and pre-defined learning outcomes. This limits opportunities for deep exploration of real-world issues. However, as Participant B8 shares, service-learning courses such as DTSI provide an alternative.

> *"In the regular classroom and courses, we [are limited to completing] our syllabus and provid[ing] some examples on applications. Students do some practical exercises but it doesn't provide [a] full picture of the overall concept. But in the DTSI, they start with [a] broad idea of the problem that they are trying to solve. We follow [the] design thinking method and this is useful in other courses too."* (Participant B8)

By implementing design thinking, faculty members guide students through problem-solving processes and refine their pedagogical techniques. As they model these practices, they also acquire new strategies that can be applied across their broader teaching requirements. The adaptability of design thinking enables faculty members to incorporate real-world challenges into their classrooms and connects them to societal needs.

4.3.2 *Sub-theme 3.2: Application of design thinking to address complex, multidisciplinary problems beyond technical areas, expanding faculty members' problem-solving capabilities*

This sub-theme emphasizes the broader applications of design thinking, particularly in addressing complex, multidisciplinary issues that require more than simply technical expertise. Faculty members who engage in service-learning are required to step outside their traditional disciplinary focus, collaborating with students and community members to tackle problems that involve social,

environmental and ethical considerations. Participant B2 reflects on the expansion of their problem-solving capabilities:

> *"In normal courses we will discuss only about our technical problems and technology. We'll get only technical skills. But this DTSI is very useful to solve some subtle problems in a design manner."* (Participant B2)

This statement illustrates the fact that faculty members are required to adopt a more holistic approach to problem-solving in service-learning courses. By applying design thinking, they learn to navigate challenges that involve technical, social and cultural understanding.

Service-learning enables faculty members to stretch their problem-solving abilities by exposing them to real-world challenges that require interdisciplinary solutions. Whether they are addressing environmental concerns, improving public health, or promoting social equity, service-learning requires faculty members to become adept at synthesizing diverse perspectives and applying them to develop sustainable solutions. Consequently, this expanded problem-solving capacity enriches their professional growth and enhances their ability to guide students in tackling complex problems in their own learning journeys.

4.3.3 *Sub-theme 3.3: Gaining a deeper understanding of community issues through conducting insightful stakeholder interviews in service-learning, informing effective solutions*

A critical element of service-learning is the direct interaction with community members, which deepens faculty members' understanding of the issues they seek to address. This sub-theme delves into the importance of empathy, sensitivity and ethical consideration when engaging with stakeholders to gather insights that will inform problem-solving efforts. As Participant B3 noted:

> *"To ask some of the questions when you go to the community, we are supposed to be very sensitive to ask some questions. You are not supposed to ask them where are your children, why they left you here. It is going to hurt their emotions. Situation-wise, they're talking to people, understanding their actual emotions."* (Participant B3)

In this reflection, the faculty member is recognizing the emotional and social complexities that arise in stakeholder interactions. The process of gathering information from community members requires faculty members to handle these conversations with sensitivity, ensuring that the perspectives they capture are both informative and respectful. Similarly, Participant B4 acknowledged the challenges inherent in conducting interviews:

> *"I understand that it is not an easy task to conduct [an] interview with anybody. It appears simple to say but requires very deep understanding to initiate a conversation and get the details which are required. Sometimes they speak a lot but when we come back and start analyzing it, we don't see what is required for the students to use in their course and learning."* (Participant B4)

Through these experiences, faculty members gain a deeper appreciation for the complexities of community dynamics and learn to approach problems with

greater empathy and awareness. Moreover, opportunities to work collaboratively on effective solutions enhance faculty members' ability to engage students in socially responsible learning experiences. Faculty members who participate in service-learning courses experience professional evolution, transforming from educators into leaders who are actively engaged in addressing societal challenges.

5. Discussion

The findings reveal that faculty members' engagement in service-learning programs enhances their teaching and learning skills. Service-learning fosters empathy in faculty members, engaging them in societal responsibilities and resulting in their roles being expanded as they become innovators, problem-solvers and changemakers. Figure 1 summarizes the discussion section.

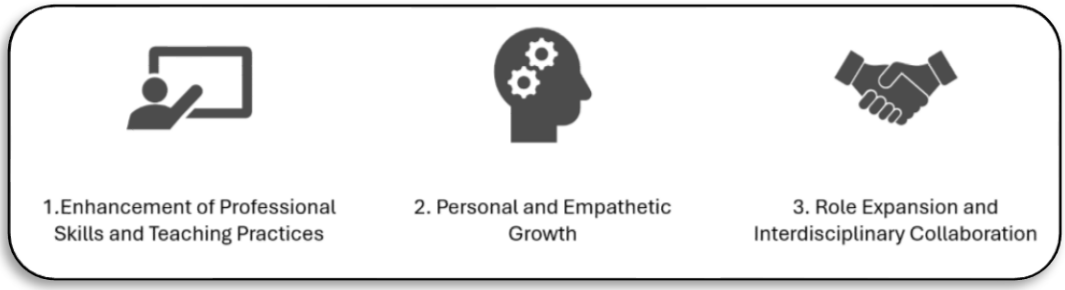

Figure 1: Faculty learning in service-learning

Faculty learning in service-learning begins with the design of service-learning courses and encompasses the learning that takes place during immersion in community settings. This process involves collaborating with students on community projects, which allows faculty members to integrate and expand their domain expertise. This progression reflects Kolb's Experiential Learning Theory (Kolb & Kolb, 2006), as faculty members engage in a cycle of designing, experiencing, reflecting and refining their teaching practices within real-world contexts. Participants reported that designing service-learning courses allowed them to integrate real-world engagement opportunities into their teaching. Thus, it enriched their knowledge and helped them to implement new methods in various academic contexts. This finding aligns with that of Eyler and Giles (1999), who emphasized that service-learning adds value to faculty members' ability to teach practical skills. The results from Section 4.1.1 highlight the enhancement of teaching competencies, supporting our first part of the research question. The necessity of acquiring knowledge beyond subject boundaries constituted a significant learning point in designing service-learning courses. Collaborative efforts between various engineering disciplines showcased the value of interdisciplinary knowledge, supporting Howard's (2001) assertion that service-learning requires interdisciplinary collaboration. This is reflected in the findings from Section 4.1.3. Designing course activities that apply academic concepts to real-world problems enhances students' practical understanding. This dual advantage of service-learning is mentioned by Bringle and Hatcher (1996), who note that it provides a platform for applying academic theories in practical contexts. Section 4.1.4 provides evidence of this practical application.

Direct community interactions during service-learning heightened faculty members' sense of empathy and societal awareness. Participants shared experiences of becoming more aware of societal needs and developing empathy, as highlighted by Meyers (2009). This exposure emphasized the importance of integrating empathy into educational practices, encouraging faculty members to adopt a more compassionate approach, as can be seen from the insights provided in Section 4.2.1. Engaging with communities catalyzed both personal and professional growth among faculty members. The accumulation of knowledge and experience through service-learning strengthened the teaching and mentoring capabilities of the participants. Similarly, Hammond highlighted the professional development benefits of service-learning experiences, noting that active participation also enhances faculty members' networks, both within and beyond the institution (Hammond, 1994). In their review of peer-reviewed literature, Tijsma et al. (2023) mentioned the role of faculty members, the factors that facilitate the institutionalization of service-learning and its benefits. Sections 4.2.2 and 4.2.3 illustrate these aspects of personal and professional development, which align with the second part of the research question of the study.

The mentorship roles taken up by faculty members in service-learning strengthened student-faculty relationships. Faculty members expressed that working with students during community visits and projects helped them to better understand student behaviors and learning needs, which aligns with the findings of Driscoll (2000). Through their involvement in service-learning, faculty members developed into innovators, problem-solvers, and changemakers. The application of design thinking facilitated innovative teaching practices and expanded problem-solving capabilities. Faculty members noted that service-learning requires a systematic approach to problem-solving. Thus, their involvement enriched their learning experience and prepared them to address complex, multidisciplinary issues. Khiatani et al. (2023) reported that during the global suffering of Covid 19, service-learning proved to be an effective method by which faculty members could take on the roles of mentors to facilitate learning across the disciplines. This finding aligns with Brown's identification of design thinking as a crucial skill that can be developed through service-learning (Brown, 2008). Furthermore, it allows for answering the research question. Sections 4.3.1 and 4.3.2 emphasize the development of these innovative and problem-solving skills. Additionally, the findings from Section 4.3.2 illustrate this transformative impact, as faculty began viewing their discipline as a platform for social impact.

Diversity in terms of gender, years of experience and departmental affiliation among the faculty participants appeared to have influenced their perceptions and experiences with service-learning. Female faculty members emphasized empathetic engagement and mentorship in a slightly different manner, compared to their male counterparts. More experienced faculty members focused on institutional goals while those with shorter tenure tended instead to consider the improvement in their teaching skills while facilitating service-learning courses. Faculty members from technical departments such as Mechanical and Civil Engineering highlighted the practical applications of service-learning, whereas those from Business Management and Humanities stressed its broader societal impacts. Such

variations highlight the ways in which differing backgrounds and professional disciplines can shape the implementation and perceived benefits of service-learning in engineering education.

5.1 Recommendations

As a result of the findings of the qualitative case study examining the learning dynamics of faculty members engaged in service-learning at a technological university in India, the following three recommendations are proposed. The first recommendation is to *integrate service-learning across disciplines.* Most of the faculty members who participated in the study highlighted that the students benefited from the multidisciplinary nature of the projects undertaken in the service-learning context. As reflected by the participants, faculty members also improved their own teaching competencies as well as their ability to integrate multidisciplinary knowledge in guiding the students. Therefore, it is advisable to integrate service-learning across a broader range of academic disciplines beyond engineering. Expanding this approach to additional fields would allow faculty members from diverse fields of study to engage in interdisciplinary collaborations. Such a collaborative approach would also enrich teaching and learning experiences.

The second recommendation is to *promote faculty reflection.* Faculty members who were involved in service-learning noted their improved mentorship abilities when they were asked to speak in their training sessions and feedback discussions. Creating spaces and opportunities for faculty members to engage in regular reflective practices, such as workshops and peer discussions, would increase faculty learning and allow educators to continuously improve their teaching. Furthermore, this would also allow for increasing student engagement, promoting collaboration and providing a supportive environment for learning.

The final recommendation from the study is to *establish faculty recognition policies*. Based on the study's findings, these programs could include awards, grants or public recognition events specifically planned to highlight innovative teaching methods, successful community engagement and impactful service-learning initiatives. Recognizing faculty achievements in this way—and adjusting their workloads accordingly—would showcase the value of these programs within the institution and would motivate other educators to adopt service-learning. By formally acknowledging the contributions of service-learning, institutions could foster a culture that values experiential learning.

Although these recommendations are based on the specific experiences of the faculty members involved in this study, it is anticipated that they will be relevant and adaptable to other institutions implementing service-learning programs. The aim is to enhance faculty development, strengthen service-learning practices and promote institutional support for these initiatives across various academic environments. By applying these recommendations, institutions and faculty members can improve the effectiveness of service-learning and maximize its impact on teaching, learning and community engagement.

5.2 Limitations of the Study

This study has some limitations due to its implementation at a single institution in a Tier 2 city in India. Service-learning in this institution is led by top management personnel and the institution has an advantage in terms of resources and the extensive educational experience of its staff. Most faculty members come from similar backgrounds and have a shared understanding of the local community. Moreover, these faculty members have some form of experience in service-learning. Therefore, the favorable community rapport may positively influence faculty members' perspectives on service-learning, compared to settings with less established community ties. Service-learning in this institution is promoted by leadership in addition to the efforts made by individual departments, which may affect faculty autonomy and innovation compared to institutions with only department-led initiatives. Also, the cultural and geographical context of this institution may limit the broader applicability of the findings to diverse or international educational environments, where community relationships and acceptance may vary significantly. Cultural traditional values are also significant; some communities may welcome student and faculty involvement in social immersion projects, whereas, in settings where personal achievements are prioritized, communities may view such collaborations less favorably. Hence, the future research agenda on faculty learning should include longitudinal studies on faculty members' learning in any institution, comparative studies across different institutions and studies of service-learning in other disciplines, including the challenges to implementation.

6. Conclusion

This study examined the impacts of service-learning on faculty learning within the context of undergraduate engineering education in India. Through the qualitative analysis, informed by the experiences of faculty members, this research highlighted that service-learning not only enhances teaching and learning competencies but also helps in significant professional and personal growth of faculty members in terms of societal empathy and innovation. The findings also reveal that faculty members become deeply engaged as co-learners with their students, actively participating in the learning process and benefiting from the reciprocal nature of educational interactions. Indeed, the implications of this study extend beyond individual faculty learning, suggesting broader institutional reforms. Higher education institutions are encouraged to adopt and expand service-learning programs, recognizing their potential to enhance faculty engagement and effectiveness. As has been demonstrated, such programs serve as a catalyst for developing educators who are not only skilled in their disciplines but are also empathetic, reflective and responsive to social and community needs. Future research should therefore continue to explore the long-term impacts of service-learning on faculty development, particularly in diverse educational contexts. Longitudinal studies could provide deeper insights into the ways in which these initial changes in teaching and learning practices affect career trajectories and educational outcomes over time. Comparative studies across different disciplines could help to identify the unique challenges and benefits of service-learning in varied academic fields. In conclusion, service-learning emerges as a powerful pedagogical tool that significantly contributes to faculty learning. By engaging faculty

members in meaningful community interactions and reflective practices, service-learning programs can play a pivotal role in shaping a new generation of educators who are well-equipped to meet the challenges of contemporary higher education and contribute positively to societal advancement.

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Appendix A (Qualitative Interview Protocol)

- Could you explain your background, including your education, career, years of experience, specialization, and type of tenure?
- Elaborate on what led to your involvement in service-learning in your institution.
- Could you share your significant experiences of delivering service-learning courses in terms of challenges? (Student learning, teaching learning

processes, support from colleagues, institutional support, community engagement etc.) In the case of challenges, what made you persevere?

- Did you see any change in your approach to teaching during SL?
- Did you acquire any new skills while facilitating SL courses?
- How did you allocate time for the preparation of SL courses? Did it help in learning?
- Did you attend any workshops, FDP (Faculty Development Program), or any other sessions to train for SL implementation? How did it help?
- Have you noticed any improvement in your knowledge after taking part in SL and, if so, in what specific areas?
- How useful are the handbooks in terms of having a comprehensive set of guidelines, templates, and documents in one place?
- Could you share your experience of the SL projects that brought recognition for you and your institution?
- Describe your experience of collaborating with the community for SL projects.
- What are students' attitudes towards the SL courses?
- Unknown users are one of the sources for SL practitioners to gain the experience of co-learning with the students and community. How did you feel when you met the community and interacted?
- Dynamic requirements are required in SL projects as they are not well structured as academic projects. Complexity of the problem is higher. How did you support your students and how did you personally learn to manage it?
- Did you get an opportunity to work with any students on applications that provide a deeper understanding of the concepts?
- How did your own learning help in mentoring the students?
- How useful has the SL experience been for your own professional growth?
- Describe anything else about your experiences that differs from traditional courses.