

# Pedagogical Implications of Service-Learning Integration in Engineering Education

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**Abstract:** Today, researchers and engineering educators are much concerned about the future of engineering students who do not receive sufficient practical knowledge about their field and its context. Some criticize the issues related to the use of resources and retention while others feel that the teaching practices in terms of effective pedagogy do not match the required learning strategies and approaches of engineering students. Thus, many educators see service-learning as one of the most crucial solution to several problems and issues that arise in the field of engineering education currently. It has been observed that over the years, the curriculum of engineering education has been subjected to fluctuations. Much work exists that focuses on the theoretical aspects of engineering education but less work has been done on the practical aspects of engineering education. In this paper we assess the potential contributions of service-learning in helping out engineering students in developing the required knowledge and skills which are applicable in the field of engineering. The results showed that integration of service-learning in engineering education was found useful for engineering students in many respects. It was found that integrating service-learning into the engineering programme was offered practical learning opportunities, experiences, contexts, and motivation to engineering students. It was further found that service-learning also promoted the goals of engineering education by engaging engineering students in a real life practical learning which enhanced their capability towards problem solving and critical thinking.

**Keywords:** service-learning, teaching and learning pedagogy, application and implications, engineering education

## I. INTRODUCTION

The expansion of knowledge due to technology has created many challenges for professionals enormously in life including the field of engineering in recent days [1]. Engineering students require some additional basic skills such as communication, teamwork and critical thinking which are required for them to become active and true professionals especially in the current competitive age [2]. However, research indicates that engineering students lack these basic essential skills which have motivated learning institutions and workplace administrations to bring about the necessary reforms in engineering education. There is a continuous call from the industry in producing well-rounded graduates who possess the required skills to deal with the challenges of

today's fast moving global economy and knowledge market [3]. Thus, essential transformations are important in engineering education so that future engineering professionals are well-equipped with the required knowledge and skills to perform well in the job market. The future engineers must have some practical know-how about the complex issues of the society in order to become effective professionals. It is important that the engineering students learn to develop essential teamwork, communication skills and awareness of social issues in order to function as successful professionals. Engineers need to develop several abilities aside from theoretical knowledge to be able to not only understand the complexity and dynamics of the job market but also have the skills to cope with the fast occurring changes in the local as well as international industry [4]. However, the continuous misrepresentation of effective practical educational tools and techniques from the field of engineering has fueled less innovative curricular models which have resulted in poor learning and engineering applications in engineering education [5]. Thus, service learning can be one of the effective strategies to be included as a new pedagogy in the core engineering curricular to handle such situations.

## II. SERVICE-LEARNING AND ENGINEERING EDUCATION

Service-learning connects the community with academic learning effectively. Apparently, service-learning has the potential to address many issues faced by the engineering education. For example, there has been a continual decline in the engineering education outreach programmes that could propel the required skills and knowledge among the engineering students' practical abilities [6] where researchers believe that this issue can be solved by adopting service-learning as a teaching strategy. Students participating in the service-learning programmes can effectively apply their knowledge learned from the classroom to address community problems. This helps to enhance their knowledge and skills while they work in the community as service providers and

contribute towards the development of the people which also adds to their personal, professional and social development [7]. In addition, placing engineering in the local community context will help broaden the view and the scope of engineering education. This will also attract many eminent students towards joining the engineering field. In this way, the engineering education will flourish more profoundly in future.

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Generally, the community context and social relevance of service-learning are closely consistent with the main principles and characteristics of engineering education. Engineering is a practical field and service-learning also provides practical learning opportunities to the students. In this way, the focus on different projects designed for community development will be effectively materialized with real community participation. This will provide a greater real-world experience to the engineering students [8], [9]. Basically, service-learning could be a new academic endeavour in the engineering field despite the fact that many successful applications of service-learning adventures in engineering field are already in place subtly, such as the Engineering Project in Community Service (EPICS). The basic aim of the project is to bring the multi-disciplinary engineering programmes into long term partnership with the local community, organizations and agencies. This project has designed, developed and implemented many supporting programmes and technology driven solutions towards the issues faced by many local communities [10]. This project which was basically initiated in the Purdue University, was extended to different engineering projects and programmes with the passage of time. Fundamentally, the project designed systems, structures to minimize home constructions and energy costs and provided building therapeutic devices to help children who had various disabilities. In addition, the project also designed and implemented wetland mitigation programmes in partnership with the local communities.

There are also various service-learning programmes which help to promote as well as facilitate the integration of international service projects into many engineering campuses around the world [11]. The basic aim of these programmes is to improve rural water supply schemes, sanitation system, create local community resource management capabilities, and develop supportive form and multi-functional energy reservation and utilization platforms in both developed and developing nations. Despite these developments and successful models of service-learning applications in engineering education, the engineering field continues to face many issues in embracing service-learning as an effective pedagogy [12]. Hesitation is found among the management of engineering to initiate service-learning as a strategy to promote the goals of engineering education [13]. Hence, this paper reviews the application and implications of service-learning in the field of engineering education.

Interestingly, many engineering educators believe that the issues of education lie in the constructivist approach where students are allowed to construct knowledge and to create connections between theory and practice. They oppose the traditional educational approach which motivates the passive style of absorbing the knowledge [14]. Hence, educators consider service-learning to be implemented it in the engineering education as it is a constructivist method of education. This method may effectively match the teaching styles with the learning styles of engineering students. It has the potential to help engineering students to integrate the theoretical knowledge with practical life experiences [15]. In this way, engineering students may easily begin to connect service-learning to their curriculum and learn practical applications of the engineering education. Researchers

believe that over the years, a decline has occurred in the utilization of multiple teaching and learning instructions in the field of engineering and the current engineering education has become fragmented [16]. After many deliberations and discussions, researchers agreed that engineering schools must try to provide some appreciation along with increasing exposures to the engineering students in the context of the societies and communities and help them develop the sense of teamwork [17]. Later studies also stressed the need for developing and implementing more extensive, practical and relevant engineering courses which are connected to the needs of the local industry and communities. It was highlighted that engineering students needed to develop professional and interpersonal skills which were essential to work as effective professionals [18]. Thus, service-learning emerged as the most suitable approach to fill this gap in the field of engineering [19]. This intention slowly increased the need of integrating such teaching and learning methodologies which could help to materialize the goals of engineering education. In this paper, we discuss how service-learning is gaining grounds in the field of engineering education by being integrated in a variety of engineering courses around the world.

### III. SERVICE-LEARNING AND ENGINEERING EDUCATION

Basically, in service-learning, classroom content is directly connected with the service aspect to promote local community as well as learning. Thus, the service performed is directly related to the academic subject matter [20]. In engineering education, this connection supplements and compliments the academic content of the course effectively in all the branches of engineering field. This experience provides wider opportunities for engineering students to learn about the different social issues in the society. Besides, service-learning also creates awareness among the engineering students about their ultimate roles as engineers to address the issues and problems faced by the communities effectively [21].

Service-learning has been defined in a number of ways. It is a credit-bearing educational experience in which students participate in an organized service activity that meets defined community needs. Service-learning also helps students to reflect on the service activity in such a way that enables them to gain further understanding of the course content, broader

appreciation of the discipline and enhanced sense of civic responsibility. There are basically four key elements or components of service-learning: service component, academic component, community partnership, and reflection [22]. Firstly, the service component is an essential part of the service-learning activity through which the needs of people and underserved communities are identified and their needs are satisfied through projects that contribute towards the general benefit for everyone in the community.

Secondly, the academic component is performed to provide reinforcement in learning by creating a sustainable connection between the content and experience and the theory and practice. Thirdly, the partnership component involves developing meaningful links on the basis of the principle of reciprocity between the community and the campuses. In this way, both students and community members work together as close shareholders or partners to address the needs and issues in the communities and equally benefit from the service experience. Besides, the community component involves creating awareness among the communities to identify their own strengths and weaknesses and approach the relevant bodies to address the issues faced by them. In this way, the community members also learn from the service aspect of the service-learning [23]. Fourthly, the reflection component is an integral part of the service-learning programme. During the service-learning activity, the participants are guided to reflect on the service performance, the process of work being done and the various implications of the service activity. This is an important meta-cognitive activity that helps to improve learning. The process of meta-cognition is monitoring one's own thinking while acquiring new information where it includes assessing the process of acquisition of new knowledge, the background, the prevailing assumptions, and the hypotheses [24]. This information can help students to comprehend the academic material thoroughly which is needed to be covered in the course, to relate the material with real life situation and to analyze the implications of the application of the new knowledge in different social contexts and situations. This knowledge helps students to identify their own roles as the change agents to find out the social issues and explore ways and means to address them. The reflection component may take several forms such as open-ended questions, written or oral discussions on topics, periodic written summaries of the work being done, assessing implications of the activity and reading materials assigned to be done [25]. Service-learning provides many benefits to all the stakeholders who are involved in the engineering service activity [26]. Table 1 shows some of the prominent benefits.

**Table 1: Prominent Benefits**

- *The capacity and resources of the community are increased.*
- *The students get richer learning experience and environment.*
- *The learning experience received through service is actually extended to all partners such as students, faculty members and community members.*
- *The community members find an opportunity to work with the faculty for the creation of a learning environment in which students effectively increase their mastery of the academic content related to the course as well as get some knowledge and familiarity with the social issues prevailing in the society. They also develop the skills to address the issues more efficiently.*
- *The college and university faculty develops*

*the abilities to understand the problems and needs of the local community and find new learning opportunities for students.*

- *Faculty finds some new avenues for research and development.*
- *The community members come to know about the role of the engineering and technology education and its applications for the mitigation of community needs and issues.*

Source : [26]

Service-learning is an experimental learning approach. One of the most important recent developments that have deeply influenced the process of learning is the 'Learning Cycle' of David Kolb [27]. Reflection is an essential principle of this learning theory. Reflection creates a link between the theory and practice or conceptualization of the topics to be covered in a course. Learning is a process in which knowledge is created through transformation of experience and learners gain knowledge by testing and adapting their existing knowledge through the process of abstract conceptualization (planning a project), active experimentation, concrete experience (observation or result tracing), and reflection (to think about improving performance and understanding) [27]. Based on Kolb's Theory, during the service-learning activity, the classroom instruction is combined with service that provides an environment in which students may increase or enhance their knowledge. The various aspects of this environment also allow the students to know the diverse learning styles at different places during the service activity till the cycle of learning is completed [27].

Service-learning is different from other service activities which are conducted either through an educational programme or community intervention. For example, service-learning provides an opportunity to compliment the learning goals as well as meets some community needs simultaneously. It provides more holistic approach towards learning. Service learning connects the social context with the real world community issues [28]. Thus, a true service-learning creates a balance between the social world and the academic world effectively as it includes a meta-cognitive activity that helps to improve students' learning.

#### IV. RECENT ENGINEERING EDUCATION

Recent engineering education faces many problems. There is a need to reflect on the issues so that the problems of engineering education could be resolved more competently as identified by the past studies [29]. One of the biggest problems of engineering education is the increasing isolation of the theory of engineering with practical life. The education in engineering has become more theoretical than practical where in many cases the engineering students lack professional skills such as teamwork, communication, interpersonal, and leadership. Apparently, these skills and abilities are essential for engineers to perform as active and effective professionals in the job market.



Engineering students are expected to possess skills and understanding of global and local economy as well as environmental and societal needs in order to function as successful professionals. This cannot be achieved without professional training and development. In this situation, many engineering educators, adopt service-learning as an effective way to overcome the professional and interpersonal skill deficiencies among the engineering students [30]. Besides, service-learning is also well-positioned to help the engineering educational institutions to achieve their professional goals [31]. Therefore, embedding service learning into the engineering education accordingly would help to dignify this profession further.

Today's world has become highly dynamic and fast. Thus, engineers need to know how to operate in such a fast and diverse global market. One of the reasons is that the technology explosion has created such needs where the traditional knowledge may become obsolete in a few years. In line with this, today's engineers are expected to do more than just making calculations and measurement. They are expected to work in teams and in different situations. They need to understand the dynamics of the current fast changing societies, multicultural environment and manage complex projects. At the same time, engineers also need to compete in a highly competitive and complex social and work environment characterized by changes and challenges. In such situations, the education of engineering may become vulnerable to many problems including teaching and learning approaches and strategies. Thus, it is timely that the teaching and learning pedagogy of the engineering education is upgraded by incorporating service learning in the engineering courses in order to cope with the current needs of fast changing world.

The internet and other advanced tools of technology and development have radically changed the way engineers work. In order to meet these insurmountable challenges, current engineers must be provided training that enables them to manage the rising challenges and changes in the job market. Service-learning has the potential to fully prepare the engineering students to be more successful in meeting the challenges and perform as better professionals since the traditional courses are unable to effectively prepare them to deal with such difficulties [32]. In addition, service-learning essentially offers many opportunities to the engineering students to address the related problems. It develops among the engineering students the abilities not only to overcome their difficulties but also perform well at the work places. Typically, service-learning enables the engineering students to get knowledge of mathematics, science and engineering in a practical way [33]. The engineering students develop the many useful abilities through service-learning programmes. Table 2 highlights some of the useful abilities.

**Table 2: Useful abilities**

- *The ability to design a system and its components, or develop processes to meet different needs of people in the society.*
- *The ability to work on multidisciplinary ways as professionals.*

- *The ability to identify, formulate and solve engineering problems and issues.*
- *The ability to communicate and interact with others more effectively.*
- *The ability to understand the effect and impact of engineering solutions on the people in local and global perspective.*
- *The ability to recognize different local and global community contextual diversity and perspectives.*
- *The ability to recognize the needs to engage in lifelong learning for personal growth and professional development.*

Source: [34]

Apart from being an effective pedagogy, service-learning also addresses many concerns of the engineering companies seeking to hire new engineering graduates who are well-equipped with relevant knowledge and skills [35]. This is because service-learning provides a real world context where the engineering students may get new experience for developing, planning and designing new things by using multidisciplinary approaches which is usually not possible in a traditional classroom environment where only knowledge is transferred through lectures. In this way, they can constantly challenge their own believes, evaluate and synthesize their knowledge which they have received in the classroom besides utilizing them to solve problems in a broader perspective [35]. Thus, service-learning has the potential to help engineering students and the field by providing them a classroom context to gain real world experience by working with community partners in the context of real community.

### V. SERVICE-LEARNING PEDAGOGICAL EFFECT IN ENGINEERING CURRICULUM

Service-learning has been incorporated in different engineering educational programmes and courses for addressing the contextual, motivational and multi-disciplinary needs around the world. In Purdue University of America, various engineering courses are running which are based on service-learning approach such as Engineering Projects in Community Services which was started in 1995. This programme helps to provide wider community exposures to the engineering students to meet diverse community needs. This programme was successful in offering practical learning opportunities, experiences, contexts, and motivation to engineering students [36]. The Penn State University has also started certificate programme known as "Humanitarian Engineering. The aim of the programme is to build relationship with the local communities. Besides being a project driven educational programme, service learning also emphasizes on closer collaborations and partnerships of universities with marginalized communities. In this programme, numerous outreach educational activities are conducted by the engineering students to target the neglected and underprivileged communities.

This allows the engineering students to have a greater understanding of the cultural aspects of engineering education and its impact on the development of technical proficiency. This programme also places much emphasis on the entrepreneurship activities. This helps the students of engineering education to present solutions to local problems and develop business plans and implement them in different targeted communities [37].

There are different ways through which service-learning can be integrated in the educational programme. Fundamentally, the integration of service-learning in the engineering education can be done in several ways such as starting with the existing courses, working with co-curricular activities and developing new programmes and courses. Apparently, service-learning component can be integrated in the existing engineering context such as mechanical and civic engineering projects. Next, service-learning can also be integrated in the co-curricular courses through some supplemental courses following the actual course with some community and reflective activities for the students. In addition, some institutions create separate courses by integrating the service-learning into the course outlines where they are designed based on the requirement of the lab and technical courses of engineering to substitute the traditional courses [38]. Furthermore, some institutions have created such programmes to meet the needs of local communities such as to help homelessness prevention, risky populations as well as child development. These service programmes integrated with civic engineering also help in cleaning and dealing with the environmental issues. The integration of service learning in the engineering programmes are advantageous to people of various walks of life as well as many industries and this matter should not be negated by the related faculties of engineering of learning institutions.

## VI. THEORETICAL FRAMEWORK

As an experiential educational method, service-learning draws much from constructivist philosophy [42]. Constructivism is a perspective or an educational theory that rooted from psychology and sociology. This theory explains that knowledge is constructed by the learners from their previous knowledge rather than the passively received or absorbed knowledge from the outside sources. Similarly, the process of learning includes both creation of new knowledge and also to understand the connection between various modes and sources [43]. Service-learning effectively creates that connection where it provides such an environment to the learners for them to construct knowledge easily and actively when they are engaged in the actual projects in the context of community. In addition, the reflection element is also embedded in service-learning. The reflection habit enables the students to think deeply and create connections between their previous and new knowledge [44]. Thus, service-learning strategy becomes a very useful and effective approach to teach the engineering courses.

As a theory, constructivism has faced some criticism both epistemologically and pedagogically. However, service-learning helps to solve this issue in the engineering education as it is taken as optional or introductory course in

institutions which basically supplements the actual courses. Second, the goal of many engineering courses is not only to have a broad and detailed understanding of the courses but also to provide the engineering students with some real practical works to learn about the real world experiences. Therefore, the educators have the liberty to incorporate service-learning into their engineering courses in a very flexible manner. There are many teaching and learning instructions which are employed in the engineering education. Some of the learning styles practised in the engineering education use visual, sensing, inductive, active learners, auditory, intuitive, deductive, passive, and sequential [45]. Apparently, learning takes place very effectively if the students are taught in the style which is the most appropriate for them. Thus, service-learning is an educational strategy that provides maximum opportunities for all types of engineering students to work and learn in their own learning styles. Students enjoy greater academic and intellectual freedom during the service activities such as to explore, critique, speak, lead, and reflect which is not possible in a traditional controlled classroom environment [46]. These skills would help the future engineers to develop their own perspectives on different issues in the community so that they could prepare themselves to suit the respective environment in the best ways possible.

## VII. RESEARCH OBJECTIVES

The main purpose of this research was:

1. To explore the implications of integrating service-learning in engineering education.
2. To determine outcomes of service-learning for engineering students.

## VIII. METHODOLOGY

In this study, an exploratory approach was employed to investigate the implications of integrating service-learning in engineering education in Pakistani context. Data was collected from 180 respondents including male and female students from two engineering colleges from Punjab province in Pakistan. A purposive sampling technique was used to select the students. All the students selected as respondents were those who had participated in service-learning projects. For this purpose, students from semester 7 were focused as they had an exclusive experience of participating in service contribution.

Before data collection, the participants were informed about the purpose of the study and their consent was sought to respond to the questionnaire. The survey questionnaire consisted of 18 items covering the following main variables or themes: learning opportunity, motivation, experience, context, problem solving and critical thinking. These themes were inductively identified based on thorough review of literature on service-learning and its application in engineering education. Thus, an item pool was created based on these themes and a survey questionnaire was developed.

For content validity, the questionnaire was shown to four experts before pilot testing. Based on the review and feedback, the items were finalized and simplified. The construct validity of the questionnaire was tested through factor analysis technique.

The outcomes of service-learning for engineering students were tested through exploratory factor analysis. In exploratory factor analysis, the underlying dimensions were determined based on a hypothesized factor structure. This technique is popularly used as an effective exploratory technique. Principal component analysis was applied to identify the major factors or outcomes of service-learning contributions for engineering students.

**IX. RESULTS AND DISCUSSION**

The results of the study are presented below based on the analysis derived from field survey data. The data were analyzed using both descriptive and factor analysis. The descriptive statistics was used to summarize the data numerically and graphically. Frequency distribution, percentage, mean and standard deviation were applied as indicated in Table 1.

**Table 1: Descriptive Statistics**

	N	Mean	Std. Deviation
statement	180	2.37	1.201
statement	180	2.57	1.308
statement	180	2.39	1.384
statement	180	3.46	1.388
statement	180	2.96	1.279
statement	180	2.90	1.387
statement	180	3.98	1.353
statement	180	4.12	1.159
statement	180	3.02	1.244
statement	180	4.28	.992
statement	180	3.80	1.279
statement	180	2.70	1.332
statement	180	3.36	1.475
statement	180	2.94	1.346
statement	180	4.23	1.206
statement	180	3.50	1.022
statement	180	3.12	1.379
statement	180	4.45	.947
Valid N (listwise)	180		

The mean scores in Table 1 ranged from 2.37 to 4.45 showing a strong indication that service-learning has strong implications on engineering education in view of both male and male engineering students. Factor analysis was conducted to determine the underlying factors or outcomes for the integration of service-learning in engineering education. Exploratory factor analysis approach was used as an analysis

technique. KMO and Bartlett’s test of sphericity were tested to identify the sample adequacy as shown in Table 2.

**Table 2: KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.678
Bartlett's Test of Sphericity	Approx. Chi-Square	423.379
	df	153
	Sig.	.000

Table 2 shows that the value of KMO is .678 and significant at .000 indicating that the sample was adequate to undertake a factor analysis. It shows that a strong relationship existed among the variables which also supported the factor analysis as an analysis technique.

**Table 3: Communalities of Extraction**

	Initial	Extraction
statement	1.000	.551
statement	1.000	.448
statement	1.000	.695
statement	1.000	.604
statement	1.000	.288
statement	1.000	.634
statement	1.000	.532
statement	1.000	.525
statement	1.000	.601
statement	1.000	.601
statement	1.000	.429
statement	1.000	.332
statement	1.000	.736
statement	1.000	.598
statement	1.000	.524
statement	1.000	.622
statement	1.000	.481
statement	1.000	.538

Extraction Method: Principal Component Analysis.

Table 3 shows the communalities of variables expressing percentages of variance in each variable as explained by the extracted factors ranging from .332 to .736. It indicates there was an increasing variation in the responses of respondents in favour of service-learning integration in engineering education.

**Table 4: Total Variance Explained**

	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Vari.	Cum. %	Total	% of Vari.	Cum. %
1	2.722	15.122	15.122	2.012	11.176	11.176
2	2.405	13.359	28.481	1.992	11.065	22.241
3	1.271	7.061	35.542	1.684	9.353	31.594
4	1.166	6.477	42.019	1.484	8.244	39.838
5	1.127	6.262	48.280	1.322	7.346	47.184
6	1.049	5.825	54.106	1.246	6.922	54.106
7						

Table 4 indicates the components, factors or outcomes of service-learning participation for engineering students. The column extraction sums of squared loadings shows only those factors which met the cut off criterion .25. It showed that eigenvalues greater than 1 of all the 18 items in the scale were calculated for extraction of factors which produced a 6 factor structure. The variance in each of the factors is 2.72 for first component having 15.12 of the total variance followed by 2.40 with 13.35 variance for component two, 1.27 having 7.06 variance for component three, 1.16 having 6.26 of the total variance for component four, 1.12 having 6.26 for the total variance for component five and 1.04 having 5.82 for component six of the total variance.

In order to reduce the number of factors and increase interpretability, the factors were rotated based on varimax rotation method. Table 5 shows the rotated component matrix containing the coefficient for the factor loadings for each variable in the scale which indicating the correlations among the variables and factors. The table 5 further shows the six factors having the variables with factor loadings for each of the variable which were above 0.5 for interpretations.

**Table 5: Rotated Component Matrix<sup>a</sup>**

	Component					
	1	2	3	4	5	6
statement	.718					
statement	.590					
statement	.820					
statement	.654					
statement		.556				
statement		.687				
statement			.543			
statement			.556			
statement			.557			
statement				.710		
statement				.654		
statement				.712		
statement					.543	
statement					.540	
statement					.836	
statement						.652
statement						.576
statement						.663

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 13 iterations.

Table 5 shows that among the six factors identified through the component analysis method have factor loadings higher than .50. It shows a strong validity for the implications of service-learning outcomes for engineering students. In the first factor, there are four variables having loadings ranging .590 to .820 which was named as 'problem solving' based on the nature of the variables. The second factor consisted of two variables with loadings ranging from .556 to .687 named as 'critical thinking'. The third factor contained three variables with factor loadings ranging from .534 to .557 which was named as "experience". The fourth factor consisted of three variables with factor loadings ranging from .654 to .712 which was named as motivation. The fifth factor consisted of three variables having factor loadings ranging from .543 to .836 which was named as "learning opportunity". The last factor consisted of three variables with factor loadings ranging from .576 to .663 which was named as "context" based on the nature of variables loading together.

### X. IMPLICATIONS

Service-learning has wider implications for engineering education as a teaching and learning pedagogy especially in Pakistani context. It is equally beneficial for all stakeholders, including students, faculty, institutions, and communities related to engineering education [39]. For example, service-learning is an important opportunity for engineering students. It enables them to apply the classroom knowledge and skills in real life context where they undergo different experiences such as working in teams, planning projects, communicating, and performing their duties professionally. All these activities develop their sense of professional responsibility and leadership skills which help them to treat the engineering education more than mere calculation and measurement projects. Integrating service learning would encourage them to become a part of the communities and explore local, global and ethical issues and problems faced by the people and try to solve them so that they are empowered as learners and leaders. Service-learning provides real mentoring opportunity to the engineering educators. Adopting service-learning strategies in teaching engineering courses provides the educators with opportunities to work with the communities and perform multi-disciplinary work. In this case, the educators of engineering courses become innovative and creative in using different teaching and learning approaches [40]. They are able to connect the course objectives with real life experiences which is one of the responsibilities of effective educators. They use innovative educational models that will impact the communities positively and also do research on different aspects of the educational activities for learning and development which lead to increased job satisfaction [40]. Thus, they develop the skills to monitor and motivate students in real life situations where they can attempt to transform the personalities of the engineering students by encouraging them to learn values and develop leadership and citizenship skills.



Service-learning provides access to new technology and technical resources for the local community to work closely with the engineering department. The community will be able to obtain services from engineers who have new capabilities and skills to solve their problems with new products and technical services at their door steps. Besides, the community will also be able to find new views of developing linkages with new investors and corporate partners. Meanwhile, service-learning also helps in improving the relationship between the engineering institutions and the local community. There would be a positive visibility of the engineering department in the community, state and beyond. Thus, the real community customers provide an environment to the engineering students where the students can find practical opportunity for critical thinking, adapting to change, communication, and using the ability to work as teams [41]. This will help in recruiting and retaining new competent employees and students for engineering discipline. This will also have a positive impact on improved student maintenance and enrollment. In this way, service-learning programme plays an important role in helping to achieve the mission of the institution. Thus, there would be an increased corporate interest in developing partnership with the community based programs in terms of engineering education.

### XI. CONCLUSION

The contemporary engineers must also compare, contrast and develop their original perspectives on issues in the community and suggest solutions. Furthermore, service-learning provides engineering students vast opportunity to contribute towards the public and society welfare. As a matter of fact, the future societies need a vast number of engineers who could meet their diverse and immense needs. Thus, it is believed that the integration of service-learning in engineering education apart from developing positive community university relationship will also help to improve the diversity and retention issues in engineering schools. This will provide the engineering students a deeper and better understanding of the needs of the society.

Being a practical, problem-solving and experiential field, engineering education provides more grounds and benefits for it is uniquely situated for the integration of service-learning. Through this review, we argue that the application and pedagogical implications of service-learning in engineering education as an experiential method provides the sustainable solutions to many problems and issues faced by the societies and communities. Thus, service-learning has the potential to engage engineering students in a real life practical learning and provides them with real life experiences and situations. These activities provide platform for the engineering students to discover issues and problems faced by the people and design programme and projects to mitigate them. Through the review of previous works, we found that service-learning provides the engineering students opportunity to apply the engineering models and theoretical knowledge gained from the classroom in real life situations. Hence, the integration of service-learning in engineering education will be useful for students to enhance their sustainability when they begin their

carriers at their respective professional work places.

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