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Does Service Learning Enhance Sustainability Knowledge, Attitudes, and Practices among University Students? An Empirical Analysis

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ABSTRACT

This study examined the impact of service-learning pedagogy on university students' sustainability-related knowledge, attitudes, and practices (KAP) within the framework of the Sustainable Development Goals (SDGs). Using a quantitative pre–post research design, data were collected from 71 university students enrolled in a semester-long service-learning course in Pakistan. The Sustainability Consciousness Scale was used to assess changes in students' sustainability knowledge, attitudes, and practices before and after the intervention. Data were analyzed using descriptive statistics, paired-sample t-tests, and Pearson correlation analyses. Findings showed that students initially demonstrated relatively high sustainability knowledge and positive attitudes, but comparatively lower sustainability-related practices. Following the intervention, sustainability practices improved significantly, while changes in knowledge and attitudes were positive but not statistically significant. Correlation analyses further indicated stronger relationships among knowledge, attitudes, and practices after participation in service-learning. The findings suggest that service-learning is an effective experiential pedagogy for promoting sustainability-related behavioral engagement in higher education.

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Keywords: Service-learning; Sustainability consciousness; Sustainable Development Goals (SDGs); Knowledge, attitudes, and practices (KAP); Higher education; Experiential learning; Pakistan.

1. Introduction

An effort on making life sustainable on Earth has gained much attention in the past decades. Most prominently, The United Nations (UN) in 2015 developed the Sustainable Development Goals (SDGs). They are a set of 17 goals and 169 targets, which aim for the sustainable future for our planet by bringing about global transformation. The SDGs address a wide range of environmental, economic, and social issues including poverty, health and well-being, climate action and more. The goals are very ambitious, and the United Nations aims for achieving them by 2030 (Afroz, & Ilham, 2020).

At the SDG Summit of the United Nations (September, 2019) world leaders called for a Decade of Action realizing progress to achieve SDGs needed much acceleration. Several civil society organizations and leaders called for a "super year of activism" to accelerate progress on the SDGs. During the summit, a key point of discussion centered on the urgent need for action during the decade 2020-2030.The UN Secretary-General called on all sectors of society to mobilize for a decade of action at three levels: global action, local action and people action. It was expected that global action will secure greater leadership, more resources and smarter solutions for the SDGs; support for local action was encouraged to facilitate the necessary transitions in policies, budgets, institutions and regulatory frameworks at different levels of governance, including governments, cities and local authorities. In addition, it was emphasized that people's action with a highlighting on the involvement of youth, civil society, media, private sector, trade unions, academia and other stakeholders to play a key role in driving the necessary transformational changes.

At the mid-point of the Decade of Action, The SDG summit Report (2025) provided a broad assessment of worldwide progress toward the 2030 agendas for Sustainable Development. It highlighted that only 35% of targets with trend data are on track or making moderate progress, while almost half are moving ahead too

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gradually and 18% of SDG goals are delayed since 2015. However, despite setbacks, significant accomplishments have been made, including universal electricity access in 45 countries, elimination of some neglected tropical diseases in 54 countries, a halving of child mortality, increased access to clean energy, and progress in education access. However, improving education quality and access was indicated as priority areas which require acceleration in efforts.

Higher education institutes (HEI) can play a unique role in creating the knowledge, attitudes, and practices necessary to achieve the SDGs through their teaching, research, and engagement activities. According to UNESCO (2025), Education for Sustainable Development (ESD) respects cultural variety while empowering students to make responsible decisions and take action for a just society, economic viability, and environmental integrity for both the current and future generations. Recent studies aiming to increase sustainability knowledge, attitudes, and behaviors among higher education students highlight the pivotal role of experiential and interdisciplinary approaches. A bibliometric analysis of sustainable development research in higher education institutions (HEIs) reveals a growing academic focus on integrating sustainability concepts into curricula and promoting faculty development, cross-institutional collaboration, and policy reforms to institutionalize sustainable practices (Osman, Sheikh, & Abdi, 2025). In order to facilitate interdisciplinary cooperation and remove institutional obstacles, another study emphasizes the necessity of a paradigm change in academic systems. It coincides with the holistic vision of the SDGs, underlining education's role in fostering comprehensive sustainable awareness across disciplines. The conversation emphasizes how multidisciplinary collaboration fosters creative problem-solving and helps dismantle academic silos. Case studies from the real world further illustrate how these cooperative methods result in useful and significant sustainability solutions. (Mittal, & Bansal, 2024). By teaching the next generation and setting an example of responsible behavior, higher education institutions (HEIs) are essential to the advancement of sustainability. Another study evaluates studies across education, health, economy, social sustainability, and transportation to identify challenges that impede sustainable implementation in HEIs. It also discusses

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markers for evaluating the effectiveness of sustainability projects and emphasizes important issues that delay progress. (Barnett-Itzhaki, Tiferet, Etstein, Gefen, Ravid, Barokas, & Levi, 2025). Collectively, these studies suggest that multifaceted, institution-wide commitments that combine curricular integration, community engagement, and ongoing evaluation are key to enhancing sustainability education outcomes in higher education. These studies also highlight that experiential and interdisciplinary approaches in education can play a promising role in enhancing sustainability learning outcomes.

Service learning is a teaching method that combines service, implicit teaching objectives, and deliberate reflection to expose students to the needs of society. Students participate in planned projects to address real-world community issues as part of this experiential learning approach. While higher education is not always a setting where change is easily achieved, service learning has demonstrated the potential to impact some of the most challenging aspects of the institution (Bringle, Hatcher, & Jones, 2023). Service-Learning (SL) encourages practical learning by enhancing participants' problem-solving, teamwork, and communication skills through the integration of learning objectives with service opportunities. Programs for international service-learning also have the potential to improve social awareness and cultural competency (Doone, Abreh, Mills, & Sungdong, 2023).

In Pakistan, research on sustainability education in higher education sector shows noteworthy gaps. Despite the global emphasis on sustainability, Pakistani HEIs encounter a number of obstacles that prevent the integration of sustainable development into curricula, research, and campus operations (Shaheen, Khakwani and Tabassum, 2024). In the context of Pakistan, there is little research on this significant construct that influences academics, students, educational policymakers, and university administration. Only seven studies on student participation have been published in the past ten years since Pakistan's higher education system is struggling to meet the demands of the approximately 500,000 students enrolled in HEIs. Only two of those seven studies were carried out at the higher education level; one was carried out at a public university and the other at a private university in Punjab, Pakistan. (Kosar, Said, & Habil, 2020). Despite numerous service-learning

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initiatives launched by educational institutions worldwide, there is currently no standardized tool to assess the challenges affecting their sustainability. A literature review revealed ten commonly reported challenges spanning various service-learning themes. (Ahmad, Deeba, & Saleem, 2024).

Considering the high relevance of service learning with youth involvement in attaining sustainable development goals it seems worth exploring a role of service learning in developing knowledge, attitude and practices related to sustainability among university students in Pakistan. Therefore, the present intervention based study aims to explore the change in the levels of students' knowledge, attitude and practices towards sustainability after engaging in service learning. As transition to sustainability requires the knowledge, attitude and practices towards sustainability (Salas-Zapata, & Cardona-Arias, 2021). Present study contributes to the literature and educators who design courses of different degree programs in higher education institutes. Foremost, this study helps in understanding the relationship of knowledge, attitude and practices related to SDG of youth. Further, it provides a link between theoretical framework and empirical research. Moreover, this study presents the link of service learning and knowledge, attitudes and practices towards sustainable development goals. Faculty members can design their courses based on it to promote the SDGs knowledge and practices. Finally, this study highlights the future direction in this area of research.

2. Literature Review

2.1 Theoretical Framework

In the present study KAP and service learning models have been used. knowledge, attitude, and practice (KAP) model have been used to understand the efficacy of social learning pedagogy for the education of sustainable development goals at tertiary education level. The KAP model offers an organized framework for analyzing the interactions between behavioral engagement, value orientation, and cognitive understanding by conceptualizing knowledge, attitudes, and practices as interconnected aspects of human behavior. In the first step it measures the level of understanding for any topic or object. Secondly, it evaluates the feeling or opinion towards that object or phenomenon (Attitude) and lastly, it examines the actual

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application of that knowledge and attitude (Das, 2021). The World Health Organization (WHO) has endorsed the promising use of the knowledge, attitude, and practice (KAP) model in collecting information on the knowledge, attitudes, opinions and behaviors related to specific issues in a relevant group and further use of evaluation references of related programs or interventions. (WHO, 2021).

In the present study KAP model has been used before and after the service learning intervention to understand service learning efficacy. Service learning is a teaching and learning technique that combines meaningful service experiences with academic activities. According to the National Service-Learning Clearinghouse (2020), service learning is a teaching pedagogy that engages learners in service projects of local agencies so that they can take part in betterment of communities and also learn from it. Current research indicates that the relationships between these dimensions are more dynamic and context-dependent than strictly linear, despite the KAP framework's frequent presentation as a sequential progression from knowledge to attitudes and then to practices. Without enabling circumstances, experiential engagement, and structural opportunities, attitudes may not always predict practice, and knowledge does not always translate into behavioral change. Rather than being a deterministic model of behavior change, the KAP framework is used in this study as an analytical lens to look at the relationships between sustainability knowledge, attitudes, and practices.

Salam (2019) stated that service learning is a name of teaching pedagogies which integrates subject knowledge with practical experiences for students to reflect and learn. Service learning is based on Dewey's theory of education, (1938) which suggests that a person learns and progresses through interactions and experiences with the world around that motivates an individual to continually develop new ideas, concepts, understandings and practices. Service learning has been found to improve academic and social outcomes for students, while also helping to build community relationships and support meaningful civic engagement. Research has shown that service learning can have positive effects on student attitudes towards school and learning, as well as helping to increase student knowledge and understanding of the subject matter (Meyer, 2016; Olberding & Hacker, 2015).

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2.2 Knowledge, Attitude and Practices related to Sustainable Development Goals among university students:

Several studies have examined university students' knowledge, attitudes, and practices (KAP) related to the Sustainable Development Goals. Several recurrent patterns can be found in research that looks at university students' sustainability-related knowledge, attitudes, and practices (KAP) in a variety of contexts. First, according to Tawok and Saidin (2025) and Radwan and Khalil (2021), students typically exhibit moderate to high levels of sustainability awareness and positive attitudes toward sustainable development goals. However, there is frequently still disparity in the conceptual depth and awareness of the SDGs' interconnectedness.

Second, research continuously shows that knowledge and attitudes do not always result in long-term behavioral engagement, even though positive attitudes toward sustainability are widespread (Jillani et al., 2025; Owojori et al., 2022). Numerous higher education contexts have documented a persistent knowledge-practice gap, indicating that behavioral change cannot be achieved solely through awareness.

Third, the relationship between knowledge and practice is often mediated by contextual, institutional, and structural factors. El-Kholei & Yassein, 2023; Alsaati et al., 2020) have identified curriculum limitations, a lack of experiential opportunities, and an abstract treatment of sustainability concepts as obstacles that hinder students from meaningfully implementing sustainable behaviors.

When taken as a whole, these studies show that while college students frequently have awareness of and favorable attitudes toward sustainability, there is still little evidence that these attitudes and knowledge are translated into consistent practice. This persistent disparity emphasizes the need for instructional strategies that shift from raising awareness to encouraging experiential and action-oriented learning.

2.3 Knowledge, Attitude and Practices related to Sustainable among Pakistani university students:

There is still relatively little empirical research on sustainability education in Pakistani higher education. Previous research mainly looks at how students feel

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about sustainability or particular environmental practices (Khattak et al., 2022; Khalid et al., 2023). Research on structured pedagogical interventions and their effects on sustainability-related practices is scarce, despite the fact that findings generally point to positive orientations toward sustainability. Specifically, there are still few studies that systematically evaluate how knowledge, attitudes, and practices change after experiential learning interventions. This disparity highlights the need for empirical research into the potential effects of pedagogical strategies like service-learning on Pakistani university students' awareness of sustainability.

This framework views service-learning as an experiential mechanism that can help students better align their knowledge, attitudes, and practices by placing them in real-world situations that call for application, reflection, and active participation. This study investigates whether structured experiential engagement improves sustainability-related practices as well as the relationships between the three KAP dimensions, as opposed to presuming a linear progression. In light of the persistent knowledge–practice gap identified in global research and the limited empirical evidence within the Pakistani higher education context, there is a need to examine whether structured experiential pedagogies can influence sustainability-related knowledge, attitudes, and practices, as well as the relationships among these dimensions. Accordingly, the present study adopts a research-question-driven approach to assess sustainability consciousness before and after participation in a service-learning intervention.

Accordingly, the study seeks to address the following research questions:

(1) What is the level of university students' sustainability knowledge prior to participation in service-learning?

(2) What are university students' attitudes towards sustainability prior to participation in service-learning?

(3) What is the level of university students' sustainability-related practices prior to participation in service-learning?

(4) What is the relationship between students' sustainability knowledge and their attitudes before service-learning?

(5) What is the relationship between students' attitudes towards sustainability and

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their sustainability-related practices before service-learning?

(6) To what extent does participation in service-learning influence students' sustainability knowledge?

(7) To what extent does participation in service-learning influence students' attitudes towards sustainability?

(8) To what extent does participation in service-learning influence students' sustainability-related practices?

(9) How does participation in service-learning affect the relationship between sustainability knowledge and sustainability attitudes?

(10) How does participation in service-learning affect the relationship between sustainability attitudes and sustainability-related practices?

3. Method

3.1 Research Design

This study employed a quantitative, pre-post research design to examine the effect of service-learning pedagogy on university students' sustainability consciousness. The pre-post design is particularly suitable for evaluating interventions, as it enables the assessment of participants' knowledge, attitudes, and practices before and after the service-learning program, providing insights into changes affected by the intervention. By using a pre-post design, the study aimed to determine not only the baseline levels of sustainability consciousness among students but also the extent to which these levels changed following participation in a semester-long, credit-bearing course. This design aligns with the study's objectives, which focus on understanding both individual development and the relationships between knowledge, attitudes, and practices in sustainability.

3.2 Participants

Participants were recruited using convenience sampling, as all students enrolled in the course during the semester were invited to participate. In total 105 university students enrolled in a semester-long, credit-bearing service-learning course participated in this study. However, data was collected from 71 (47 male and 24 female) students as some of them did not answer either the pre- and/or the post-SC scale. Most students had no prior formal service-learning experience, although a few

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had engaged in volunteer activities.

The sample included students from various academic programs, with the majority from Business Administration, followed by Computer Science and Fashion & Design. Participants voluntarily provided informed consent and were assured of confidentiality and the right to withdraw at any time.

3.3 Research Tool

For this study, data were collected using the Sustainability Consciousness (SC) Scale (Gericke et al., 2019). The SC Scale is a validated instrument designed to measure students' knowledge, attitudes, and practices related to sustainability. It consists of 50 items divided into three parts measuring, respectively, students' knowledge of sustainability concepts (19 items), students' values and attitudes towards sustainability (14 items), and the frequency and extent of sustainability-related practices (17 items) across the environmental (17 items), social (20 items), and economic (13 items) dimensions.

The scale employs a Likert-type scoring system, with higher scores indicating greater sustainability knowledge, more positive attitudes, and more frequent sustainability-related practices. The SC Scale has been empirically validated and shown to be reliable (Gericke et al., 2019). In this study, it was administered before and after the semester-long service-learning course to assess changes in students' sustainability consciousness.

3.4 Data Analysis

Beyond descriptive statistics, SPSS (Version XX) was used to conduct inferential analyses to examine differences between students' pre- and post-intervention sustainability consciousness scores across the domains of knowledge, attitudes, and sustainability-related practices. Paired-sample t-tests were performed to examine statistically significant differences between pre- and post-intervention scores for sustainability. In addition, Pearson's correlation analyses were conducted to examine relationships among the variables before and after the service-learning intervention. All statistical tests were evaluated at a 5% significance level ($p \leq .05$).

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4. Result Analysis:

Table 1: ***Demographical Information***

Variable	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Sex	Male	47	66.20%	66.20%	66.20%
	Female	24	33.80%	33.80%	100.00%
	Total	**71**	**100.00%**	**100.00%**	
Program	Business Administration	56	78.90%	78.90%	78.90%
	Computer Science	12	16.90%	16.90%	95.80%
	Fashion & Design	3	4.20%	4.20%	100.00%
	Total	**71**	**100.00%**	**100.00%**	

Table 1 shows the demographic information where the sample size is 71 students reflecting 66.2male and 33.8female. The sample consists of 78.9% Business Administration, 16.9% Computer Science and 4.2% Fashion and design.

Table 2: ***Reliability Analysis***

	Reliability Statistics		
	Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
Knowledge	.877	.884	19
Attitude	.795	.826	14
Practice	.751	.758	17

Table 2 shows Reliability analysis of the variables where Cronbachs Alpha of all three scales (Knowledge, Attitude, Practice) are greater than 0.70 meaning acceptable to excellent reliability.The scale with the highest level of internal consistency is the Knowledge scale 0.877.

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Table 3: ***Descriptive Statistics***

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Pre_Knowledge	71	1.000	5.000	3.807	0.644	0.415
Post_Knowledge	71	1.420	5.000	3.970	0.565	0.319
Pre_Attitude	71	1.140	5.000	3.917	0.572	0.327
Post_Attitude	71	1.000	5.000	3.974	0.658	0.432
Pre_Practice	71	2.060	5.000	3.378	0.518	0.269
Post_Practice	71	1.000	5.000	3.528	0.549	0.301
Valid N (listwise)	71					

Table 3 shows descriptive analysis where the mean score of 3.80 is that the level of knowledge that students possessed about sustainability prior to service-learning was moderately high. The standard deviation of 0.644 represents the average variability of the responses, i.e. the majority of students possessed the same degree of knowledge. The lowest score of 1 indicates that there were a small number of students that were extremely knowledge deficient, but on the whole the group was fairly knowledgeable.

The average attitude score of 3.91 is large, which means that the students were rather positive in terms of attitude towards sustainability, even prior to the program. The smaller standard deviation 0.572, indicates that there was more uniformity in the attitudes amongst the sample.

The lowest score of 1.14 shows the presence of negative attitudes, or neutral attitudes, but presumably, not many of them. As the mean of 3.38 indicates, there was a moderate level of pre-service-learning sustainability-related practices. This score is significantly weak when compared to both knowledge 3.80 and also attitude 3.91 meaning that there might be some gap between what the students know and what they do in actual sense. The distribution between 2.06 and 5.00 is to suggest that none of the students has a very low score, yet there is a room in which practice behaviors can be improved.

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Table 4: *Paired Samples Statistics*

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	**Pre_Knowledge**	3.807	71.000	0.644	0.076
	Post_Knowledge	3.970	71.000	0.565	0.067
Pair 2	**Pre_Attitude**	3.917	71.000	0.572	0.068
	Post_Attitude	3.974	71.000	0.658	0.078
Pair 3	**Pre_Practice**	3.378	71.000	0.518	0.062
	Post_Practice	3.528	71.000	0.549	0.065

The average knowledge score improved by 0.163, which is positive when compared to the pre-service learning knowledge score of 3.81, meaning that the students were able to acquire knowledge related to sustainability as a result of the service-learning intervention. Standard deviation was decreased by 0.644 to 0.565, which indicated responses that were somewhat more consistent after the intervention. Nonetheless, this descriptive enhancement is apparent, but the paired samples t-test in table 6 showed a p-value of 0.055 that is slightly above the traditional significance value of 0.05 thus the change is not statistically significant. On the whole, there was a slight descriptive improvement in the knowledge of students, but the effect was not significant and statistically insignificant.

There was a slight improvement of 0.06 in the mean attitude score between 3.81 and 3.97 post service-learning intervention, but this is a relatively small practical difference. Also, the standard deviation increased to 0.658 instead of 0.572, indicating a little more varied responses of the students after the intervention. The outcome of the paired samples t -test (p = 0.551) proves that this change is not statistically significant and the calculated value of the effect size (Cohen d = approximately 0.07) proves a very negligible impact. On the whole, no significant difference in the attitude of students towards sustainability was detected. The fact that the attitudes were already high before the intervention could also be a ceiling effect, where there was not much room to achieve any significant improvement.

The average score of students in terms of sustainability related practices was lower

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before the service learning intervention 3.378 but improved to 3.528 after the intervention which is a positive change in behavior. This would imply that after participating in the program, students were more involved in practices that are sustainable. Also, the standard deviation increased 0.518 to 0.549, indicating a slight change in variability of the responses of students. Generally, the descriptive statistics indicate a significant increase in sustainability practices, as this is also associated with the desired outcome of the service-learning experience. The results of the paired samples t-test in table 6 shows that the mean difference between the pre- and post-practice scores was found to be -0.151 with a t-value of -2.147 and a p-value of 0.035 that is statistically significant at level 0.05. The confidence interval of the difference between the two was 95 percent, with a lower bound of -0.290 and a higher bound of -0.011, which shows that the change observed may not be the result of a chance event.

Table 5: ***Paired Samples Correlations***

Paired Samples Correlations				
		N	**Correlation**	**Sig.**
Pair 1	**Pre_Knowledge & Post_Knowledge**	71.000	0.328	0.005
Pair 2	**Pre_Attitude & Post_Attitude**	71.000	0.181	0.131
Pair 3	**Pre_Practice & Post_Practice**	71.000	0.388	0.001

Table 5 shows the correlation between pre- and post-intervention scores on sustainability knowledge, attitude and practice. In Pair 1 (Pre_Knowledge and Post Knowledge), Pearson correlation is 0.328 and p-value of 0.005 that demonstrates a statistically significant, small to moderate positive association between the knowledge of the students before and after service-learning intervention. This indicates a moderate positive association student who were higher in knowledge levels prior to the intervention were more likely to maintain or even enhance their knowledge levels after the intervention.

In Pair 2 (Pre_Attitude and Post-Attitude) the correlation is 0.181 with a p-value of 0.131 and is small and not significant. It means that the relationship between the

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pre- and post-attitudes of students towards sustainability was not always consistent and that did not consistently predict on their initial levels.

In Pair 3 (Pre_Practice and Post practice), the correlation is 0.388 and the p-value is 0.001, and it is a moderate correlation between sustainable practices of the students, pre- and post-intervention. This implies that students who were already practicing sustainability prior to the program had intended to retain relatively higher level the practices after the program.

Table 6: ***Paired Samples Test for Pre-& Post Sustainable Practices:***

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre_Knowledge - Post_Knowledge	-0.163	0.704	0.083	-0.330	0.003	-1.953	70.000	0.055
Pair 2	Pre_Attitude - Post_Attitude	-0.056	0.790	0.094	-0.243	0.131	-0.600	70.000	0.551
Pair 3	Pre_Practice - Post_Practice	-0.151	0.591	0.070	-0.290	-0.011	-2.147	70.000	0.035

The above table 6 shows the results of the paired samples statistics, and the t-test. This revealed that there was a significant enhancement of the student involvement in sustainability related practices following the intervention of service-learning. In descriptive an increase in the sustainability practices between the mean score of 3.38 before the intervention and 3.53 after the intervention with a positive change in the behavior. Even though the standard deviation has slightly increased 0.518-0.549 showing in table 4, indicating that the variability of the responses also increased, the overall change in the mean scores speaks of general success in the sustainable actions of the students.

The paired samples t-test also supported this improvement as it showed a

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statistically significant difference in pre- and post-intervention scores. The mean difference was -0.151 with t-value of -2.147 and p-value of 0.035 which is less than the normal threshold of 0.05. The 95% confidence interval of the difference was -0.290 -0.011, which confirms the view that the difference is not likely to occur as a result of chance variation.

Overall, the findings indicate that the level of engagement of students in the practices related to sustainability significantly increased after their engagement in service-learning, which implies that the intervention produced a positive and quantifiable effect on the behavior of students.

Table 7: ***Correlations Analysis for Pre-Sustainable Practices***

Correlations

		Pre_ Knowledge	Pre_ Attitude	Pre_Practice
Pre_Knowledge	**Pearson Correlation**	1.000	.684**	0.208
	Sig. (2-tailed)		0.000	0.082
	N	71.000	71.000	71.000
Pre_Attitude	**Pearson Correlation**	.684**	1.000	.491**
	Sig. (2-tailed)	0.000		0.000
	N	71.000	71.000	71.000
Pre_Practice	**Pearson Correlation**	0.208	.491**	1.000
	Sig. (2-tailed)	0.082	0.000	
	N	71.000	71.000	71.000

**. Correlation is significant at the 0.01 level (2-tailed).

According to table 7, there was a strong positive relationship among the university student's knowledge of sustainability and their attitudes towards it prior to their service-learning experience (r =0.684, p =0.000). This implies that students with a better knowledge about sustainability were more likely to have a positive attitude towards it as well. Also, there was a moderate, although statistically significant,

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positive correlation between the attitudes of students towards sustainability and their practices related to sustainability (r = 0.491, p = 0.000). This indicates that more positive students were more likely in sustainable behavior even before the intervention. The relationship between knowledge and practice (r = 0.208, p = 0.082) was weak but meaningful, however, pointing to the fact that knowledge alone did not have a substantial predictive power of student's engagement in sustainable practices pre-service-learning.

Table 8: ***Post-intervention correlation***

Correlations

		Post_Knowledge	Post_Attitude	Post_Practice
Post_Knowledge	**Pearson Correlation**	1.000	.729**	.542**
	Sig. (2-tailed)		0.000	0.000
	N	71.000	71.000	71.000
Post_Attitude	**Pearson Correlation**	.729**	1.000	.654**
	Sig. (2-tailed)	0.000		0.000
	N	71.000	71.000	71.000
Post_Practice	**Pearson Correlation**	.542**	.654**	1.000
	Sig. (2-tailed)	0.000	0.000	
	N	71.000	71.000	71.000

**. Correlation is significant at the 0.01 level (2-tailed).

According to the results of the post-intervention correlation, the correlation between the knowledge of sustainability and attitudes towards it in students increased after service-learning. The Pearson Correlation between the Post Knowledge and Post Attitude is r = 0.729 and p = 0.000, which means that there is a strong and statistically significant positive correlation between the two. This implies that, post-intervention, the relationship between the knowledge and the attitude of the students towards sustainability was much better, as compared to the pre-intervention correlation (r = 0.684).

On the same note, the correlation between the attitude of students and their practice related to sustainability also increased with the intervention. Pearson correlation between, Post Attitude and Post Practice, r=0.654 (p=.000) indicates

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accepted statistical standards. This is a positive change in comparison to the pre-intervention effectiveness (r = 0.542), implying that positive attitudes of students towards sustainable behaviors were stronger aligned with their real sustainable behaviors after service-learning.

Finally, the relationships between knowledge and attitude, as well as attitude and practice, improved considerably post-service-learning program, which become more closely linked in enhancing the relationships between what students know, believe, and do in terms of sustainability.

5. Discussion and Conclusions

The present study examined sustainability-related knowledge, attitudes, and practices (KAP) of university students, as well as the relationships among these dimensions, before and after participation in a service-learning intervention.

The results show that the students had relatively strong sustainability knowledge and positive attitudes towards sustainability even prior to participation in service-learning. The relatively limited variation in students' sustainability knowledge suggests that participants the course with a broadly comparable level of understanding. While a small number of students appeared to have minimal prior knowledge, the overall pattern indicates that the most students were familiar with sustainability concepts.

Similarly, students demonstrated largely positive attitudes toward sustainability even before the intervention. The consistency observed in attitude reflects a shared recognition of the importance of sustainability among university students. This sustainability knowledge and positive attitude even before the intervention suggest that students already had some level of exposure through either formal education or media, or broader societal discourse.

However, the study finds that students' sustainability-related practices were only moderate and notably lower than both knowledge and attitude scores. This gap is consistent with previous studies on sustainability education which reveal that while students may have knowledge of sustainability and express favorable attitudes towards it, they may lack sustainability practices. These studies establish that knowledge and attitude do not automatically translate into consistent sustainable

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behaviour (Finger, 2010; Arbuthnott, 2009; Webb & Sheeran, 2006). The factors such as structural constraints, limited opportunities for action, habitual behaviors, and the abstract nature of sustainability concepts may limit students' ability to enact sustainability in their daily lives despite having knowledge and favourable attitudes (Heimlich & Ardoin, 2008). These factors highlight that the relationship between knowledge, attitudes, and practices, as suggested by the KAP framework, is not strictly linear. Instead, it is complex and mediated by multiple factors. This baseline gap provides insight into the importance of pedagogical approaches that may help move beyond knowledge -building towards practice through experiential engagement.

The pre-intervention correlation analysis reveals a strong positive relationship between sustainability knowledge and attitudes. This finding aligns with previous research which show that students with higher levels of knowledge are more likely to have positive attitude towards sustainability (Núñez-Tabales et al., 2024). Furthermore, this result also fits with the conceptual assumptions of the KAP framework. The KAP framework emphasizes knowledge's foundational role in shaping attitude and values (Schrader & Lawless, 2004).

Moreover, a moderate positive relationship was observed between sustainability attitudes and sustainability-related practices prior to service-learning. This finding substantiates the previous studies which establish that favorable attitudes encourage sustainable behaviors to some extent, even in the absence of structured interventions (Núñez-Tabales et al., 2024, Wendlandt Amézaga et al, 2022; Sahin et al., 2012). However, the relationship between knowledge and practices was weak and not statistically significant. This finding supports all previous research that challenge simple knowledge-driven behaviour change approaches in sustainability education and reinforces the idea that cognitive understanding is insufficient for behavioral change unless accompanied by other enabling conditions, motivation, and opportunities for action (Marcos-Merino et al., 2020; Ahmad, Noor, & Ismail, 2015; Frisk and Larson, 2011).

In contrast to expectations, the results show only a slight, non-significant increase in students' sustainability knowledge. This can be explained in light of the service-

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learning intervention's focus on applied and contextual learning, which is not fully captured by surveys measuring factual knowledge. Additionally, students' moderately high baseline knowledge may also have limited the potential for increase. Although the standard knowledge test shows little change, this does not rule out the possibility that practical learning was enhanced following the service-learning intervention.

Similarly, students' attitudes towards sustainability did not show a statistically significant change after the intervention. Given the already high pre-intervention attitude scores, this finding may reflect a ceiling effect, where students' positive orientations towards sustainability were already well established.

In contrast to knowledge and attitude, the results indicate statistically significant improvement in students' sustainability-related practices after participation in service- learning. The findings build on existing research, including educational case studies, which demonstrate that experiential learning activities can promote transformative learning and behavioral change (Wongklang & Sovajassatakul, 2020; Frisk and Larson, 2011; Segalas, et al.,2010; Sipos, et al., 2008). It highlights the distinctive contribution of service-learning as an experiential approach in transforming students' practices through behavioral engagement and developing skills essential as change agents.

The post-intervention analysis shows that the relationships among sustainability knowledge, attitudes, and practices became stronger after participation in service-learning. The association between knowledge and attitudes increased, and the relationship between attitudes and sustainability-related practices became notably stronger. Most importantly, the relationship between knowledge and practices became both moderate and statistically significant after service learning intervention. This represent the substantial improvement compared with the weak baseline association between the sustainability knowledge and practices.

These post-intervention improvements are consistent with prior researches on behavior change in sustainability education, which suggest that experiential pedagogies help translate knowledge and positive attitudes into concrete actions by providing contextual and structural support for engagement (Alharbi et al., 2025;

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Arbuthnott, 2009). These studies also emphasize the role of experiential pedagogies in bridging the gap between knowledge and attitude, and in reducing the disconnect between attitudes and practices. Thus, the present study extends this literature by showing that service-learning, as an experiential pedagogy, not only enhances sustainability practices but also strengthens the relationship among knowledge, attitudes, and practices over time. These findings highlight its role in bridging the gap between knowledge, attitudes, and practices.

5.1. Theoretical Contributions

From a theoretical perspective, the present study makes twofold contribution to the education for sustainability research. First and foremost, it highlights the role of service-learning as an experiential pedagogy that facilitates the translation of knowledge and attitudes into concrete sustainable practices. It provides insight into the role of service learning as a mediating mechanism through which awareness, values, and attitude may influence action. Though, many studies have suggested that service-learning has the potential to help higher education institutions transition toward Education for Sustainablity (Alvarez-Vanegas, Ramani, & Volante, 2024; Aramburuzabala & Cerrillo, 2023). To best of our knowledge, this study is the first to use a KAP framework with a service-learning intervention to empirically demonstrate this potential.

Secondly, the study extends existing theory by showing that learning experiences themselves can shape the interplay between knowledge, attitudes, and practices. Thus, it emphasizes the integrative nature of sustainability learning that connects knowledge, attitude and action.

5.2. Practical Contributions

The findings of this study also have practical implications that are helpful for higher education institutions in promoting sustainability and preparing more responsible citizens. The study identified service-learning as an effective pedagogy in sustainability education for enhancing students' overall sustainability consciousness. Moreover, by reinforcing the integrative nature of sustainability learning, the study argues that curricula that focus only on imparting sustainability knowledge may fail to influence students' practices. It is recommended that, to achieve sustainability

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learning outcomes, educators teaching for sustainability focus on experiential pedagogies such as service-learning.

5.3. Limitations and Future Directions

Despite its contributions, the study has certain limitations that should be acknowledged and considered. First, the use of a single institutional context and a relatively small sample size may limit the generalizability of the findings. Therefore, to enhance the generalizability of the findings, more such research should be conducted in different difference academic and cultural context.

The second limitation involves the reliance on self-reported measures which may introduce response bias. It is important that the future research also uses qualitative methods to get deep insights into students' sustainability learning process. Moreover, there is need to use advanced statistical techniques to better explore how relationships change.

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