Knowledge, Importance and Inclusion of SDG in Engineering Curriculum – A student's perspective

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Abstract— Education is the means to take the sustainable development goals forward. Sustainable future cannot be built with out the strong foundation of education. With the challenges and concerns grappling across the globe, engineers have a big role to play, especially with regard to the implementation and attainment of sustainable development goals. This study attempts to measure the knowledge level of engineering students regarding sustainability and UN Sustainable development goals. This study also aims to measure the understanding and perception of students understanding towards importance of SDG in their every day life. As our country has a population that is mostly from rural backgrounds, the study also attempted to analyze if there is difference between rural and urban students' level of understanding on sustainable development goals. Finally, the paper attempts to measure student's willingness to learn sustainability concepts as a part of their curriculum. The study followed a descriptive research method. Data for the study was collected from 250 engineering students from west Tamilnadu comprising of 7 states. This region also is the hub for engineering education in the state. The survey was developed based on a thorough literature survey and standardized instruments were identified and administered through online mode. The result of the study indicates that the knowledge levels on SDG is low among the students. The understanding and importance of goals to the everyday life was found to be significant. The study also revealed that rural and urban students differ in 5 SDG's that pertain to their functioning. The results also indicate that majority of the students were willing to be involved in the SDG implementation and interested in having them in their curriculum.

Keywords — Knowledge on Sustainability, Understanding of Sustainable Development Goals, Importance, Inclusion of SDG in Engineering Curriculum

JEET Category — Research

I. INTRODUCTION

Education is the foundation for creating a sustainable future, and both are intertwined. Empowering future decision-making individuals is a major role of education to face the dynamic and multifaceted, key issues of the 21st century. They include accommodating the change , being progressive and together creating a sustainable future. There has been a period of exceptional growth in the economy for the past few decades, to this day. Approximately around 2.3 earths are needed to support the present level of energy use, current consumption, as well as waste production of resources (Bell, 2016). In context to the social disparities across the world, like the excessive consumption of earth's resources, fossil fuel usage and other harmful chemical substances, it becomes imperative for engineering education across the world to give importance to sustainability. It is important to include sustainability in engineering education because the role of engineers in developing solutions that will improve the quality of life and also protect the environment, is crucial. Skills such as critical thinking, decision making, communication, creativity and teamwork can be developed by including sustainability in engineering education, which are essential to confront complicated global challenges.

II. REVIEW OF LITERATURE

A. Sustainability and Sustainable Development

In his work on triple bottom line, Elkington, J. (1994) defines as "simultaneously pursuing economic prosperity, environmental quality, and social equity. It implies that an organization or society should strive to meet the needs of the present generation without compromising the ability of future generations to meet their own needs." According to Brundtland, G. H. (1987) defined sustainable development as "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Kate Raworth, in her book "Doughnut Economics," introduced a novel concept for sustainability. She suggests that the goal should be to create economies that operate within the doughnut, where the inner ring characterizes the minimal social foundations (e.g., healthcare, education) and the outer ring represents the planetary boundaries (e.g., climate change, biodiversity loss). Sustainability, in this context, is achieved by balancing these two dimensions. In recent years, there is a lot of discussions on regenerative sustainability. This concept goes beyond the idea of sustaining current conditions and focuses on restoring, revitalizing, and improving ecosystems and communities. It promotes practices that aim to leave the environment and society better than they were before, rather than simply maintaining the status quo.

B. UN Sustainable Development Goals

In the year 2000, millennium goals were formulated, these formed the foundation for creating 17 SDG's and 169 detailed goals by UN in the name of Sustainable Development Goals. In the year 2015, the United Nations implemented the 2030 Agenda for Sustainable Development, which incorporates the above 17goals. These goals were classified into 5 clusters encompassing peace, people, partnerships, planet and prosperity (SDGs 1-5 for the people; SDGs 6, SDG's12-15 for the planet; SDGs 7 to 11 for prosperity; SDG 16 for peace; and SDG 17 for partnerships. D'Amato et al., (2019), discusses that these goals jointly exemplifies a wide-ranging structure covering environmental, and community-based financial characteristics, whose objective is to deal with poverty, discrimination of inequality, climate change, and depletion and other challenges like exploitation of natural resources. The 2030 Agenda of United Nations signifies an action to make joint efforts by the government and the society, to effectively achieve the SDGs (Hajer et al., 2015).

C. Sustainability Literacy (Knowledge on Sustainability)

Elena et al., (2019) define Sustainable literacy is an understanding, identification and translation of sustainability concerns that have repercussions on sustainability. Sustainability literacy is defined by Nolet (2009) as ability to solve problems and make appropriate decisions for comprehending and solving the sustainability issues. Tilbury (2011) describes the same as "more than conveying new knowledge and, also means learning to: ask critical questions; envision more positive futures; clarify one's own values; think systemically; respond through applied learning opportunities; and to explore the dialectic between tradition and innovation". Walid El Ansari, and Arran Stibbe (2009) opine that Sustainability literacy is "the ability to reflect critically on both self and society, and rewrite both self and society in ways which increase the human health and wellbeing while simultaneously protecting or enhancing the natural systems which support life".

D. Understanding and Importance of the 17 SDG

Though the stakeholders believe that engineers should be educated on sustainability, a major challenge in implementing the same is a lack of consensus on which competencies to be addressed in the curriculum. Research by Novieastari, E., et al (2022) assessed the awareness and perception of students on SDG in three different disciplines, though the knowledge of students were reasonably good and most of the students perceived them positively, on an average 40% of the student community who took part in the survey, had no clarity on SDGs. A curricula that encompasses Sustainable development and exclusive seminars or webinars on the SDGs could be organized for college students to help improve the awareness and knowledge levels. Environmental sustainability and health of students get improved by the promotion sustainability consciousness among college students. Chen, M., Jeronen, E., & Wang, A. (2021). The higher the dissemination of SDGs to students the higher shall be their understanding and which will result in a transformative education, which will seek to increase their capacities. Study by Zamora-Polo (2019) indicated that the university students generally have very low knowledge on UNSDG's. The same study also found that the various channels and sources like college teaching, social media, internet, and social networks which students use regularly gave them very little information.

E. SDG Inclusive Engineering Curriculum

Crofton (2000) is one of the most cited and seminal works discusses about the need for engineering curriculum to be a pivotal area for disseminating sustainability and SDG across the world. The research work discusses in depth the desirability for technical institutions to focus on sustainable. Higher Education Institutions (HEI's) especially engineering institutions across the country have been an important stakeholder for change, in making their curriculum inclusive of sustainable development goals, Lozano, R. (2014). Research study undertaken by Azapagic et al., (2005), proves that engineering graduates awareness and knowledge on sustainable development goals were relatively low. However, In India there seems to be a better understanding of SDG among youth in not only engineering but also in management disciplines. Ovais, D., Simon, R., & Hasan, S. (2023) in their study indicate that India's focus on achieving SDG, in this decade, is fundamental in progressing towards the global 2030 agenda, however a substantial amount of work is yet to be taken up. The role of engineering institutions and educational institutions at this juncture becomes even more important than any other times to realizing the SDG in India. Making higher education curriculum inclusive of sustainability science also results in creating awareness regarding global sustainability issues, it helps in behavioral change of students, making them more responsible towards the use of natural resources, it assists in improving their environmental consciousness and hence cater to the issues at their regional and at national level, opine Priyadarshini, P., & Abhilash, P. C. (2020).

III. RESEARCH GAPS

Engineering education shall help combat the Growing global sustainability concerns such as climate issues, natural resource depletion and social inequalities which requires engineers to develop sustainable solutions (Bansal, P. (2019). The existing literature on engineering education indicates that there is a need for technical and general competences and it requires implementation of an interdisciplinary approach in technical colleges and universities, to develop skills necessary for graduates to make them employable in the labor market. Focusing attention on a holistic and wide curriculum like sustainability, design thinking, languages studies, art forms and such other aspects, has become the need of the hour, Zeidmane, A., & Cernajeva, S. (2011). According to the literature review there is dearth in certain competencies for engineering students, innovation and creativity being an important skill the students should equip themselves with to excel in this ear. Also, to

realize the 2023 agenda of Sustainable Development Goals (SDG), and to meet the demands of industry 4.0, engineering education should undergo a sea change. This research therefore attempts to measure the knowledge of engineering students, their interest in inclusive curriculum.

IV. OBJECTIVES AND METHODOLOGY

The study had the following objectives
1. To measure the knowledge on sustainability and SDG among undergraduate engineering students
2. To assess the student's level of understanding and importance of the 17 SDG
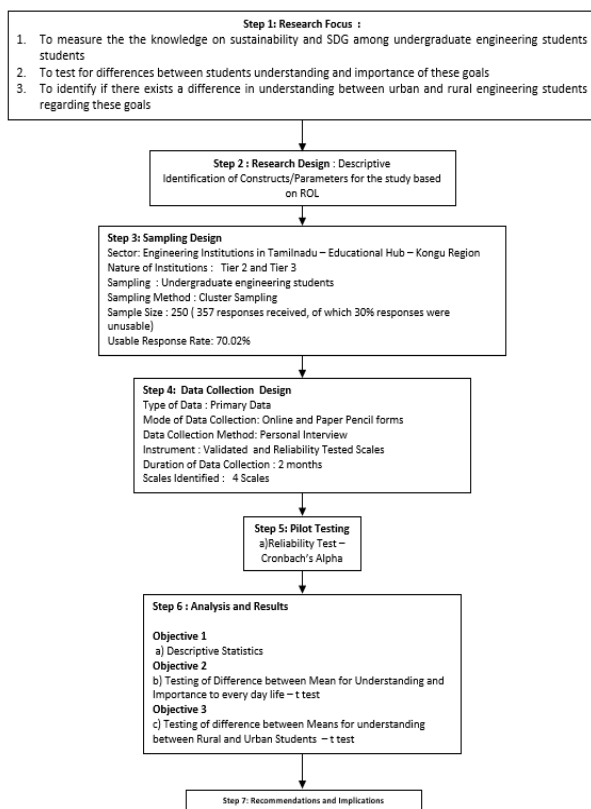3. To test for differences between students understanding and importance of these goals

Fig. 1. Methodology adopted (Source:Author).

1. To identify if there exists a difference in understanding between urban and rural engineering students regarding these goals
2. To assess the student's interest in including SDG and sustainability as a part of their engineering curriculum

The methodology adopted for this research study is discussed below. This study is following a descriptive design, carried out in engineering colleges in the eastern Tamilnadu. The population comprised of all the institutions in the geographic Kongu belt which comprised of 7 districts. Engineering colleges in these regions were chosen for the study as this

cluster comprised of some of the tier 1, tier 2 and tier 3 institutions. This region being the educational hub of Tamilnadu, it consisted of maximum engineering colleges in the state. The students studying in these institutions were from both rural and urban backgrounds. As the study attempted to measure the difference between the understanding level of rural and urban students it was essential to include institutions which had both rural and urban students. The data was collected for the study using a structured questionnaire. The study had the first construct on knowledge on SDG was measured using 5 items adapted from Zamora-Polo (2019). Constructs measuring student's level of understanding of the sustainable development goals and their importance in their everyday life was measured by listing the 17 goals and requesting students to state their level of agreeableness to the statements on a five-point Likert scale. The next construct on student's interest in including SDG as a part of the curriculum was compiled form different sources of literature. The sample size for the study included 250 engineering students from all across different branches of study.

Majority of the engineering students who participated in the research study were from the age of 22 years comprising 47.6% (199 respondents), students in the age of 20 and 21 were 11.2% and 39.6% respectively, the remaining being 19 years of age and 1.6%. the gender-based classification of males comprising 50.8% (127 respondents) and females comprising 49.2% (123 respondents). Likewise, 62% (155 respondents) belonged to urban background and 38% (95 respondents) belonged.

V. RESULTS AND DISCUSSION

The first objective of the study was to measure the level of the knowledge on sustainability and sustainable development goals among undergraduate engineering students. It was a self-reported measure comprising of 4 statements. The statements included self reported statements pertaining to a) knowledge on the sustainable goals, b) ability to indicate at least one goal, c) countries covered under them and d) the timelines for the goals. The study measured the engineering student's knowledge on SDG. It can be seen that students have reported that knowledge about sustainability/SDG with a mean of 3.57, also most of them could indicate at least one of the goals, with a mean of 3.20. However, when questioned about the countries which are covered under SDG, the timelines for which the SDG are designed, the mean scores were 2.73 and 2.71 respectively. The most important result of this analysis brings out that though the students are aware of the SDG at a superficial level, their understanding of each of the goals in depth and what each of the 17 goals address, is very low (mean = 2.64). Again, this indicates that the engineering education system should address the gaps.

TABLE 1
RESULTS OF T TEST FOR MEASURING THE DIFFERENCE BETWEEN
UNDERSTANDING AND IMPORTANCE AMONG ENGINEERING GRADUATES

No	SDG	U	I	Paired t	Sig	Hypotheses
1	No Poverty	4.26	4.38	-1.4	.160	Refuted
2	Zero Hunger	4.11	4.39	-3.4	.001	Supported
3	Good Health and Wellbeing	4.28	4.58	-4.4	.000	Supported
4	Quality Education	4.13	4.60	-7.4	.000	Supported
5	Gender Equality	3.88	4.23	-3.6	.000	Supported

6	Clean Water & Sanitation	3.96	4.27	-4.0	.000	Supported
7	Affordable & Clean Energy	4.22	4.21	.11	.906	Refuted
8	Decent Work & Economic Growth	4.00	4.25	-3.2	.001	Supported
9	Industry Innovation & Infrastructure	4.19	4.13	.77	.438	Refuted
10	Reduced Inequalities	3.88	4.33	-5.0	.000	Supported
11	Sustainable Cities & Communities	4.20	4.29	-1.2	.214	Refuted
12	Responsible Consumption & Production	4.09	4.20	-1.5	.119	Refuted
13	Climate Action	3.98	4.07	-1.2	.203	Refuted
14	Life Below water	3.75	3.88	-1.5	.134	Refuted
15	Life on Land	4.34	4.08	2.8	.005	Supported
16	Peace and Justice	4.17	4.26	-1.2	.213	Refuted
17	Partnerships for the goals	4.27	4.28	-.10	.921	Refuted

(Note: U – Understanding of the SDG I – Importance of the SDG in everyday life)

The second objective was to assess the student's level of understanding of the 17 SDG and their importance for everyday life. This objective also tested for differences between understanding and importance using a paired t test, the results of which are depicted in the below table 1

The hypothesis formulated to measure is as follows:

Ha: There is a significant difference between engineering students understanding of SDG and their perception about the level of importance of the SDG in everyday life.

With a level of significance of 0.05 level, The formula for the paired t-test used is given below

$$t = \frac{\Sigma d}{\sqrt{\frac{n(\Sigma d^2)-(\Sigma d)^2}{n-1}}}$$

Where d : is the difference per paired value and
n: is the number of samples

17 paired t tests were carried out to test for differences, out of which 8 tests supported the hypotheses that there is significant difference in understanding and the level of importance to everyday life with respect to zero hunger, good health and wellbeing, quality education, gender equality, clean water and sanitation, decent work and economic growth, reduced inequalities and life on land. In all these cases it can be seen the mean value for importance is higher than the mean values for understanding. This implies that even though student's do not have an in-depth understanding of the sustainable goals they have understood the impact and the need for the same in their everyday life. Out of the 17 paired t tests 10 tests refuted the hypotheses, proving that there is no difference between understanding and the importance of SDG's in everyday life. The following goals - No Poverty, Affordable & Clean Energy, Industry Innovation & Infrastructure, Sustainable Cities and Communities, Peace and Justice, Partnerships for the goals, Responsible Consumption and

Production, Climate Action, Life Below water dis not have any difference. The mean scores of these goals showed equality and hence it can be understood that though the students lagged in their understanding of these goals they also felt these goals do not impact their life on an everyday basis.

The third objective of the study was to identify if there exists a difference in understanding of 17 SDG between urban and rural engineering students. This called for administering an independent t test. The hypothesis formulated to test the same is as follows:

Ha: There is a significant difference between urban engineering students understanding of SDG and their rural counterparts

TABLE 2
RESULTS OF T TEST FOR MEASURING THE DIFFERENCE BETWEEN UNDERSTANDING OF SDG AMONG URBAN AND RURAL ENGINEERING STUDENTS

No	SDG	U	R	t	Sig	Hypotheses
1	No Poverty	4.18	4.38	1.60	.111	Refuted
2	Zero Hunger	4.17	4.03	1.16	.243	Refuted
3	Good Health and Wellbeing	4.32	4.20	1.17	.243	Refuted
4	Quality Education	4.41	3.68	6.63	.000	Accepted
5	Gender Equality	4.17	3.44	4.06	.000	Accepted
6	Clean Water and Sanitation	4.02	3.89	0.94	.344	Refuted
7	Affordable & Clean Energy	4.23	4.22	0.01	.985	Refuted
8	Decent Work & Economic Growth	4.17	3.77	3.01	.003	Accepted
9	Industry Innovation & Infrastructure	4.16	4.29	1.08	.278	Refuted
10	Reduced Inequalities	4.04	3.67	2.89	.004	Accepted
11	Sustainable Cities & Communities	4.34	3.98	2.77	.006	Accepted
12	Responsible Consumption & Production	4.14	4.03	0.82	.413	Refuted
13	Climate Action	3.96	4.04	0.63	.526	Refuted
14	Life Below water	3.70	3.84	0.86	.391	Refuted
15	Life on Land	4.33	4.37	0.39	.694	Refuted
16	Peace and Justice	4.17	4.18	0.05	.955	Refuted
17	Partnerships for the goals	4.30	4.22	0.62	.532	Refuted

(Note: U – Mean of Urban student's ; R Mean of Rural students understanding on SDG)

Similar to the earlier objective 17 independent t tests were administered, of which 12 were refuted and 5 were accepted. First the hypotheses which were accepted include quality education, gender equality, decent work and economic growth, reduced inequalities and sustainable cities and communities. Understanding of these 5 goals were found have significant difference between the urban and rural engineering students. The mean score of the urban students were much higher than their rural counter parts. However, for the 12 other SDG's the mean score of the rural and urban students were found to have no difference and hence the null hypotheses that there is no difference between the rural and urban student's with respect to these goals is confirmed. This could also be due to the reason

that there is less awareness about the goals among the students. The fourth and final objective of the study was to assess the student's interest in including SDG and sustainability as a part of their engineering curriculum. Simple mean and standard deviation were computed to measure this objective.

Self-reported questions relating to student's inclination to have an inclusive engineering curriculum was measured and the results are given in table 3. The mean scores were highest for students' interest to be involved in SDG's attainment roadmap and should also learn about the issues with a score of 4.39.

TABLE 3
RESULTS OF STUDENT'S PERCEPTION ABOUT INCLUSION OF SDG IN CURRICULUM

Inclusion of SDG in Curriculum	Mean	Std Dev
1. I would like my engineering curriculum to include and help me learn about SDGs	4.21	0.82
2. Students should be involved in SDGs attainment as well as learning about the issues	4.39	0.63
3.The issues covered by the SDGs should be incorporated and embedded into all university and college courses	4.24	0.77
4.I'd like to be more involved in action that helps to achieve the SDGs	4.14	0.82

The mean score for incorporating the SDG in college or university courses and willingness to learn more about the same in engineering curriculum had a score of 4.24 and 4.21 respectively. Unlike the mean scores for knowledge which were approximately in the range of 3 to 4 , the means scores in inclusion in engineering education is high. The mean score for wanting to be involved in the action to achieve SDG is 4.14. This is a welcome sign that colleges and universities in India can make SDG a part of the curriculum and students will be willing to accept the same.

VI. LIMITATIONS OF THE STUDY

The survey measures the self-reported knowledge, understanding, and importance of students. Though there are several literature citing the self-reported measures as being effective. Some supplementary methods could have been adopted for the study. The study failed to collect data from premier institutions of the country namely IIT and NIT's. The knowledge and understanding of students at these institutions could be higher.

VII. SCOPE FOR FUTURE RESEARCH

Future research could incorporate more variables like sustainability literacy. It can aim to measure the impact of knowledge and interest in SDG and their responsibility towards achieving the goals. Research can also assess the impact of demographic variables like age, gender, branch, UG /PG on the different study constructs. A comparative study between branches that have incorporated SDG in the curriculum and those, which have not included can be studied.

VIII. CONCLUSION

The study aimed at assessing the knowledge level of engineering students with respect to sustainability and SDG, it was found to be low. Many students level of understanding of the sustainable goals were at superficial level and no indepth understanding of the goals were present. It is high time that colleges and universities take sufficient steps to incorporate sustainability education and create ecosystems in education to support and teach Sustainable development goals to students. A part of the research measured the rural and urban divide. The results indicated that the for most of the SDG , both the rural and urban students are unaware and for five SDG's urban students have more understanding than their rural counterparts. Engineering institutions should take progressive steps at governance level, at program level and also at course level to bring in a sea change that will include Sustainable Goals into education. This will go a long way in building the competencies of the engineering students both at a personal level and also at a professional level.

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APPENDIX – SURVEY USED FOR DATA COLLECTION

This questionnaire aims to assess the level of knowledge, awareness, and attitudes towards the Sustainable Development Goals (SDG) and the 2030 Agenda,

1.. a) Age _____ b) Gender - Male /Female   c) Schooling - Urban /Rural

3	How well you know	Very Well	Fairly Well	Some what	Not much	Do not know
1	How well do you know sustainability/SDG?					
2	I know what the 17 SDGs are.					
3	I know the countries to which SDGs are addressed.					
4	I know the time horizon for which the SDGs are designed.					
5	I know the number of SDGs and could indicate one of the goals					

2.. Choose the source of information from which you first became aware about SDG

a. Lecture   b. Friends   c. Advertisement   d. Book   e. Social media
f. Website   g. Web news   h. Newspaper   i. Television   j. Others

Extent of your Understanding of each goal					UN Sustainable Development Goals	Extent to which each goal is important to your Personal Life				
Fully	Partially	Somewhat	Very Little	No		Very Imp	Partially	Somewhat	Not much	Not at all
					1. No poverty					
					2. Zero hunger					
					3. Good health and well-being					
					4. Quality education					
					5. Gender equality					
					6. Clean water and sanitation					
					7. Affordable and clean energy					
					8. Decent work and economic growth					
					9. Industry, innovation and infrastructure					
					10. Reduced inequalities					
					11. Sustainable cities and communities					
					12. Responsible consumption and production					
					13. Climate action					
					14. Life below water					
					15. Life on land					
					16. Peace, justice and strong institutions					
					17. Partnerships for the goals					

3. We'd also like to know what you think about how and why, if at all, the Sustainable Development Goals (SDGs) should be included in your studies... To what extent do you agree or disagree with the following statements? (SA – Strongly Agree, A – Agree , N – Neutral , DA – Strongly Disagree, SDA – Strongly Disagree)

A	I would like to learn more about the SDGs	SA	A	N	DA	SDA
B	Students should be involved in critiquing and influencing how the SDGs are achieved as well as learning about the issues					
C	The issues covered by the SDGs should be incorporated and embedded into all university and college courses					
D	I'd like to be more involved in action that helps to achieve the SDGs					

To what extent do you agree or disagree with the following statements?

A	The government should actively lead and support achievement of the SDGs	SA	A	N	DA	SDA
B	Businesses should actively lead and support achievement of the SDGs					
C	Charities and NGOs should actively lead and support achievement of the SDGs					
D	Universities should actively lead and support achievement of the SDGs					
E	Individual people like me should actively lead and support achievement of the SDGs					

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