Activity-Based Assessment for Sustainable development in Transforming Engineering Education

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Abstract—**Sustainable Development (SD) competencies are an important area in engineering education. Engineers play a major role in working and adapting the latest technology sustainably. Undergraduate students who the future individuals are taking the engineering education towards the development of a modern sustainable world must exhibit certain objectives. The implementations of two of the objectives are being highlighted in this paper. The first is to make the students undergo self and sustainable learning through illustrations and activities which results in the enhancement of knowledge there by improvising the competence levels in acquiring skills and knowledge. The second objective is to reduce the burden of stress by integrating learning with real-time human values through the approach of right thinking, peaceful thoughts, and emotional balance. Applying the activity-based assessment through the course called Universal Human Values is considered which further makes the students learning more joyful through presentation sand interactions in a group which results in enhancing communication skills and finally submitting the report. A very important outcome of a student-centric system is a continuous internal evaluation of student performance. Compared with the last two decades, the internal assessment was based only on class tests which resulted in a lack of a teaching-learning process. In this paper, the continuous assessment through activities-based self-learning is presented with the documented results considering the case study. Exploring the social values at the macro-level and paying attention to the overall development of human values. Finally, the analysis shows the transformation of learning from a teacher-centric to a student-centric method. This helps in improving overall academic performance.**

Keywords—**Activity based Assessment (ABA); Engineering Education; Human Values; Higher Education; Sustainable Development (SD), Universal Human Values, (UHV)**

JEET Category— **Practice (Transforming Engineering Education for Sustainable Development)**

I. INTRODUCTION

Due to technological challenges, there is a demand for skilled engineers, and this could be met in all countries through sustainable engineering education and practice. To solve interdisciplinary problems which are caused by the Global transformation process and sustainability issues are identified by high degrees of complexity and responsibility. Undergraduates need to be prepared to work in teams and think critically to solve complex problems to achieve SD. On one hand, there is high demand for skilled professionals; hence the present graduates are prepared to face all kinds of competencies, such as cognitive, affective, and behavioral domains. On the other hand, these domains cannot be achieved only through normal lecturing methods, instead, students are motivated to work in teams and Inter-trans-disciplinary projects linked to project-based learning. To make the students solve problems, graduates must consider their own educational goals, which require introspection about their human values and ethics with the right understanding. Thus, teachers play a major role in inculcating the habit of solving problems within themselves and preparing the students to work as change agents and responsible for transforming engineering education for SD and developing policies, strategies, and methods that enable a more sustainable future to be built. Thus, Sustainability plays the important role in engineering education.

II Methodology – Common Framework

Higher education systems need to work on creating a platform to focus on skill sets and develop skilled engineers to understand the impact of SD to ensure the quality of life for Sustainable development. For graduating sustainable engineers, three main parameters are required, one is Competence, second is Pedagogical analysis and the third is education structure for the required learning processes. The first parameter—competencies focus on knowledge/understanding, skills/abilities, and attitude, with more emphasis on SD. The second main parameter focuses on how this process can make this, achievable through the proper pedagogical strategies. The last parameter looks at the outlook of the UHV curriculum as well as the structure needed to achieve the goal of graduating sustainable engineers.

An assessment tool that measures one course with the case study is developed here, where nearly 64 students have participated out of 83 students. The present-day outcome-based model is "Learner Centric, rather than traditional "Teacher Centric". To evaluate and compare SD competencies

for undergraduate students in all the Institutions, Bloom's taxonomy is used. Bloom's Taxonomy provides an important framework to design teaching methodologies based on different levels. Learning is divided into three types of domains.

- A. Cognitive domain
- B. Affective domain
- C. Behavioral domain (Psychomotor domain)

According to revised Bloom's taxonomy, the levels in the cognitive domain are as shown in Table I.

Table I: Bloom's level at Cognitive domain

Level	Descriptor	Level of Attainment
1	Remembering	Recalling the previously learned material
2	understanding	Explaining ideas
3	Applying	Using the information in another familiar situation
4	Analyzing	Breaking information into the part to explore the relationships
5	Evaluating	Justifying a decision
6	Creating	Generating new ideas

Secondly, while evaluating the affective domain, the following set of five major categories is used to evaluate attitudes learning domain competencies. These categories are listed as shown in Table II.

Table II: Bloom's level at the Affective domain

Level	Descriptor	Level of Attainment
1	Receiving	Be aware of phenomena & willing to tolerate
2	Responding	Commit in some small measure to the ideas & materials
3	Valuing	Attach value to an object like a commitment to responsibility
4	Organization	Organize or formulate a career plan, A systematic approach to problem-solving
5	Characterization by a value complex	Work Independently & diligently

The third domain mainly focuses on skilled behavior with seven categories as listed in Table III.

Table III: Bloom's level at the Behavioral domain

Level	Descriptor	Level of attainment
1	Perception	Basic awareness
2	Set	Recognizing one's current ability to do so
3	Guided Response	The beginning stage of mastering a physical skill
4	Mechanism	The intermediate stage of mastering a skill
5	Complex over Response	Performing complex movements automatically without hesitation
6	Adaptation	Skills are so developed that they can be modified depending on certain requirements
7	Origination	The ability to create new movements depending on the situation or problem

The second framework is the Pedagogical structure: There are many pedagogical strategies to learn SD competencies. Here are a few structures adopted in our college

- A) Think-pair & share: Mainly focuses on the active participation of students in the class.
- B) Project-based learning (PBL): Linked to real trans-disciplinary projects; hence it is the pedagogy to implement for project development.
- C) Case studies: Used to explore real-time Situations and bring demonstrations of progress towards sustainability.
- D) Role play: It facilitates the introduction of critical thinking.
- E) Problem-solving: It prepares the students to be committed & responsible.

The third framework is the curriculum structure: As per the curriculum considered, out of 17 SD goals, goal Number 4, which indicates quality education, is being addressed in this paper. And other goals can also be introduced in one or the other courses every year. The curriculum for sustainability is very much dependent on SWOT analysis. SWOT stands for strength, weakness, opportunities & threat.

- A) Strength: Includes Leadership, Increase in active learning & coordination unit.
- B) Weakness: Incentive structure & Discipline.
- C) Opportunities: Benchmarking from peer Institutions.
- D) Threat: Lack of pressure from employers.

Among all the three frameworks, few methods have been shown to be successful in acquiring SD competencies by engineering students.

III Implementation

As an autonomous college, we have implemented the proposed method. Here, we have written additional Course Outcome to measure the ABA method and surveyed the Google Forms for the students who are studying in the 4th semester with approximately 83 students and received 64 responses. The survey questions and responses are presented in figures 1 to 12. Survey Competencies, Pedagogical analysis and Curriculum structure, based on the student's feedback are as follows.

Q1) Did working in groups help you in understanding group dynamics?

Q2) Did your teammates support you in preparing PowerPoint Presentations?

Q3) Did you build a good rapport while preparing the report?

Q4) Were you encouraged by your facilitators during the process?

Q5) Did this method help you in building confidence as an individual?

Q6) Would you, like to be assigned this kind of ABA in future courses?

Q7) Do you think it is easy to evaluate individuals in a group?

Q8) At the level of society, the human goal is right ----------- & right ------------

Q9) ------------ is the feeling of being related to the other

Q10) ---------- The feeling of responsibility towards the body of our relative

Q11) ----------- is the foundational value among all Human values

Q12) Our purpose, program & Potential is the same, and we are complementary to each other is called ---------------

For the Question 1, which addresses the competency method, it can be observed that 70.3% of members are having major point scale and 28.1% of members are having minor-scale for the feedback as shown in fig 1.

Fig 1: Feedback for Survey No.1

For the Question 2, which addresses the competency method, it can be observed that feedback obtained is 60.9% of members are on a major point scale and 35.9% of members are on a minor point scale as shown in fig 2.

Fig 2. Feedback for Survey No. 2

For the Question 3, which addresses the competency method, It is noticed that 67.2% of members are on a major scale and 32.8% of members are on a minor scale for the feedback as shown in fig 3.
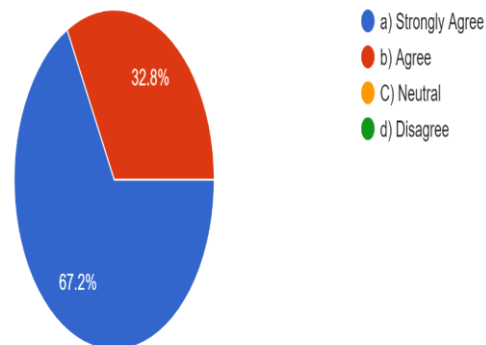

Fig. 3.Feedback for Survey No. 3

For the Question 4, It can be observed that 65.6% of members having a major scale, and 31.3% of members are having a minor scale for the feedback as shown in 4, inferred from pedagogical analysis.
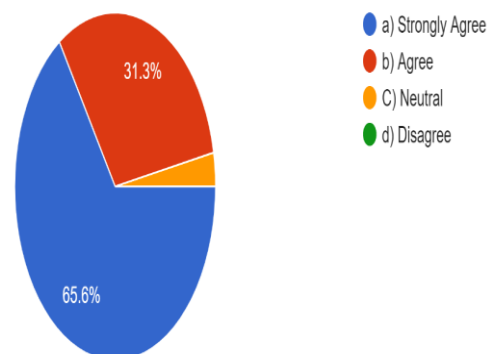

Fig. 4. Feedback for Survey No. 4

5. Did this method help you in building confidence as an individual?
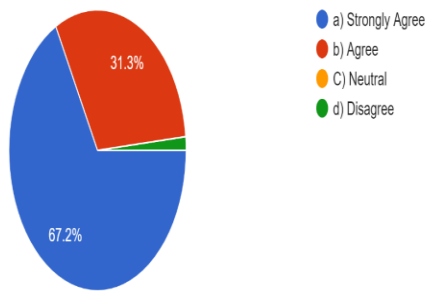64 responses

Fig. 5. Feedback for Survey No. 5

For the question 5, It was noticed that67.2% of members are on a major scale and 31.3% of members are on a minor scale for the feedback as shown in fig 5, inferred from the pedagogical analysis.

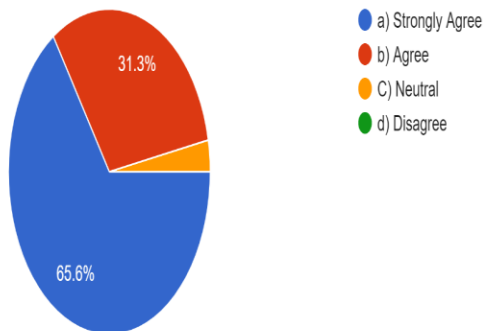6. would you like to be assigned this kind of ABA in future courses?
64 responses

Fig. 6. Feedback for Survey No. 6

For the question 6, It is observed that 65.6% of members are having major scale and 31.3% of members are having a minor scale for the feedback as shown in fig 6, inferred from pedagogical analysis.

7. Do you think it is easy to evaluate individually in a group?
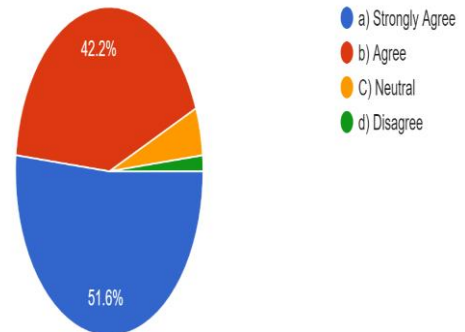64 responses

Fig. 7. Feedback for Survey No. 7

For the question 7, It can be noticed that 51.6% of members are on a major scale and 42.2% of members are on a minor scale for the feedback as shown in fig 7, inferred from the competency.

8. At the level of society, the human goal is right ---------- & right ----------
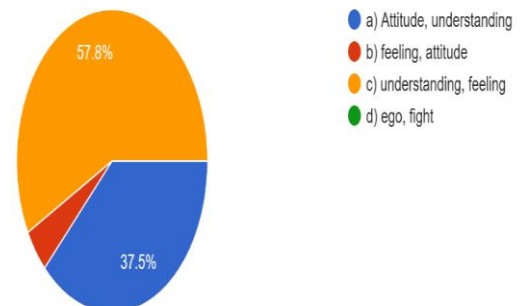64 responses

Fig. 8 Feedback for Survey No. 8

For the question 8, It can be observed that 57.8% of members are on a major scale and 37.5% of members are on a minor scale for the feedback as shown in fig 8, inferred from the curriculum method.

9. ---------- is the feeling of being related to the other

64 responses

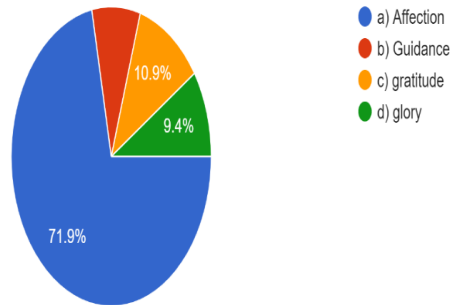- a) Affection
- b) Guidance
- c) gratitude
- d) glory

Fig. 9.Feedback for Survey No. 9

For the question 9, it is noticed that 71.9% of members are having a major scale and 9.4% of members are having a minor scale for the feedback as shown in fig 9, inferred from the curriculum method.

10. ---------- The feeling of responsibility towards the body of our relative

64 responses

- a) Glory
- b) Trust
- c) Care
- d) None of the above

Fig. 10. Feedback for Survey No.10

For the question 10, it is observed that 60.9% of members are on a major scale and 26.6% of members are on a minor scale for the feedback as shown in fig 10, inferred from the curriculum method.

11. ---------- is the foundational value among all Human values

64 responses

- a) Gratitude
- b) Trust
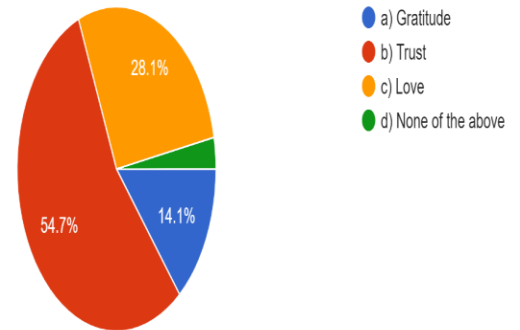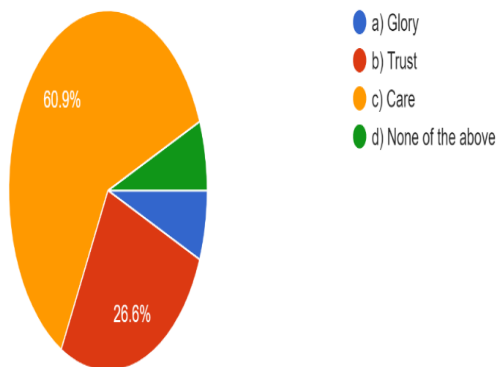- c) Love
- d) None of the above

Fig. 11Feedback for Survey No. 11

For the question 11, it can be observed that 54.7% of members are on a major scale and 14.1% of members are on a minor scale for the feedback as shown in fig 11, inferred from the curriculum method.

12 Our purpose, program & Potential is same and we are complementary to each other is called --------------

64 responses

- a) Respect
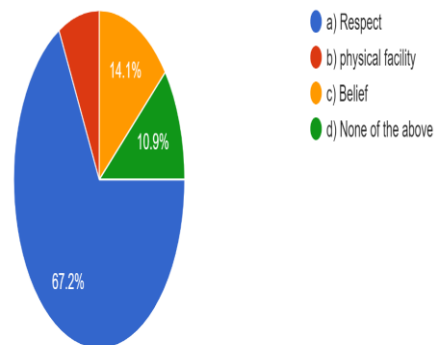- b) physical facility
- c) Belief
- d) None of the above

Fig. 12. Feedback for Survey No. 12

For the question 12, it can be noticed that 67.2% of members are on a major scale and 10.9% of members are on a minor scale for the feedback as shown in fig 12, inferred from the curriculum method.

IV Results & Discussions

Developing sustainable engineering education and practice is a global concern, especially at the undergraduate level. A Questionnaire was conducted among the student members and

their feedback was accomplished for the competencies, pedagogical analysis and curriculum structure as listed. Education for Sustainable Development (ESD) in engineering is significant for the training of agents of change and transformation that can support policies, strategies, and methods that enable a more sustainable future to be built. Most of the teacher-centric methods are laborious and slow, incapable to provide assessment in real-time. Thus, the activity-based assessment is based on real-time with the following description.

1. In every section a group of 4 students was formulated and out of many environmental problems, one of the issues was assigned to each of the student groups.

2. Students then were requested to do a thorough study about the problem, bring out the consequences, highlight the impact affecting society, and finally formulate the solutions to overcome the issues in the upcoming future.

3. And they were also instructed to provide a Presentation on their studies and finally to submit reports.

4. Presentation in the form of PPT slides and the contents must include all the details as per the Rubrics provided.

The performance by students gives the idea to the faculty as to what level the students have understood the topic (as required by the OBE), and it also helps in giving feedback to students.

V Conclusion

Introducing sustainable development in Engineering Education through Activity based Assessment is the requirement of the hour. The methods with three parameters, competency, pedagogical analysis and curriculum structure are required in order to fulfill the sustainability in a developing society. These parameters will improve the assessments which try to measure how well engineers can face SD challenges. As per the analysis of feedback, from the figures 1 to 12, we conclude that students achieve better cognitive, affective and behavioral learning with this kind of ABA. There the group work depends on the dynamic interaction and collaboration of multiple learners. The analysis shows the improvement in course learning beyond the conventional teaching method. This helps in improving academic performance.

Course outcomes (CO) are the attribute that the students are expected to express after completing the course. The assessment of Cos is important to assess whether the students have attained what is expected out of them. The assessment results are used to evaluate the attainment of Program Outcomes (PO). Further, it is used to improve the teaching and learning experience in a particular course. Finally, the evaluation of the attainment of course outcomes is carried out using the data from continuous assessment tests and the Activity-based assessment method. This method is referred to as course-embedded measurement. Here with this case study, we try to carry that, this method can be one of the best-suited methods to test the CO / PO level of students in each course/program, making it much more appropriate for Outcome Based Education (OBE) implementation. Thus, education can greatly become joyous

and helpful to every stakeholder in Transforming Engineering Education for SD.

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