

2023

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Recommended Citation

McKennedy, J., & Bedri, Z. (2023). Mapping The Sustainable Developmental Goals And Student Perspectives On Skills Development Using Alternative Assessments For Engineering Education. European Society for Engineering Education (SEFI). DOI: 10.21427/HY03-7N88

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MAPPING THE SUSTAINABLE DEVELOPMENTAL GOALS AND STUDENT PERSPECTIVES ON SKILLS DEVELOPMENT USING ALTERNATIVE ASSESSMENTS FOR ENGINEERING EDUCATION (PRACTICE)

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Conference Key Areas: 1. *Innovative Teaching and Learning Methods*, 2. *Embedding Sustainability and Ethics in the Curriculum*

Keywords: *Student perspectives, Student-created videos, in-class debates, assessment, sustainability engineering education.*

ABSTRACT

Student-created video and in-class debate were introduced in the assessment of education for sustainable development (ESD) in an environmental engineering module. This work was undertaken with a group of structural and civil engineering students in their stage 3 of study for a level 8 degree. There were 63 students registered for this course: 40 civil and 23 structural. Prior to any intervention, a linking exercise was undertaken to map the words in the module descriptor to the Sustainable Development Goals (SDGs). This informed the design of the assessments.

After completion of the respective assessments, student surveys were used to understand the student perspective on the use of these techniques. Students perceived acquisition of skills was analysed and qualitative questions relating to the attainment of knowledge were reviewed.

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The Student-created video was a summative individual assessment worth 5% of the final mark while the in-class debate was a formative assessment where students were required to work in groups of 4/5.

INTRODUCTION

1.1 Education for Sustainable Development

Education for Sustainable Development as a subject is a relatively new idea. It emerged in the late 1980s (Hopkins, 2012) due to the revolutionary advent of the sustainability concept by the Brundtland Commission in 1986 (Brundtland, 1987). It is complex and multifaceted. The 17 sustainable development goals (SDGs) are interlinked at every level and it is difficult to separate one from another. Educating engineers for the future cannot be achieved without incorporating the SDGs at every opportunity.

1.2 Mapping the SDGs

When mapping SDGs to academic modules, a direct link can be made between SDGs and some disciplines (e.g. Water and Environmental Engineering, Food Sciences). The connections between other disciplines and the SDGs might be less obvious or might need further consideration. Therefore, the first step is to identify the SDGs that are most related to the module description, its learning outcomes, and syllabus. A useful tool to help with linking SDGs and modules is SDG keywords (ITS, 2021). SDG keywords were originally compiled for the purpose of mapping research discipline areas and their outputs to SDGs but have become increasingly used for the purpose of mapping modules to SDGs (Adams et al. 2020) In this work, the learning outcomes for the module were linked to the SDGs using keywords as outlined in (ITS, 2021).

1.3 The use of student-created video and in-class debate in assessment

Both formative (in-class debate) and summative (student-created video) assessments were used in this work. Assessment fulfils a number of important functions in the learning process. These functions include but are not limited to, allowing students to determine if they have attained a satisfactory level in a given study area and facilitating educators to identify if students ability to study specific subjects (Ashwin et al., 2020). Formative assessments are desgined to show students how they can improve and do not contribute to any academic credit while summative assessments are used to indicate knowledge and skills at a given point in time and to provide academic credit (Yorke, 2007). In this work in-class debate was

operated as a formative assessment and the student-created video was a summative assessment.

Cebrián Bernat et al. (2019) has made a number of recommendations in relation to the use of both formative and summative assessment in ESD: comparison of different assessment tools against sustainability competences; design and test assessment tools with ESD principles of critical thinking, collaboration and teamwork in mind. In this instance the use of group work in the in-class debate contributes to developing the skills of teamwork and collaboration. Technical knowledge acquisition, and time required for video production are some of the skills that have been reported as learning outcomes from student-created video (Campbell et al., 2022). Students have reported that video creation is useful in reinforcing concepts taught during class (Greene and Crespi, 2012). Positive impacts of student generated videos are reinforcement of learning, more active learning, more engagement and enjoyment of learning.

2 METHODOLOGY

2.1 Linking the SDGs to the Module Descriptor

The module descriptor was scanned to highlight the main keywords (e.g. sanitation, wastewater, water, sewage, pollution, water quality) and these were matched with the SDG keywords obtained from the list developed in (ITS, 2021). The matching exercise has resulted in a number of SDGs, some less obvious than others, that may be related to the module. Following the linking of the SDGs to the module descriptor, the assessment of sustainability attributes was designed.

2.2 Formative and summative assessments for ESD feedback

Surveys for both assignments were developed in line with those devised and validated by (Watson, 2013). Students were given the option of completing the survey using online Microsoft forms or in hard copy having completed the respective assessment.

The research questions posed were (1) What knowledge do students have about the SDGs after the in-class debate? (2) What knowledge do students have about water sustainability after the student-created video assignment? (3) What skills have been developed through the assignments?

In this survey students were asked to rate their responses to quantitative statements relating to the assessments using a Likert scale where a score of 1 indicated “Strongly disagree” and a score of 7 represented “ Strongly agree”. The quantitative data which were analysed here, were those associated with the acquisition of critical thinking skills.

The quantitative statements that were posed which will be analysed here in relation to the in-class debate were:

- a. Participation in the in-class debate improved my ability to analyze the potential impacts of the sustainable development goals
- b. Participation in the in-class debate improved my ability to evaluate the importance of each Sustainable Development Goal in an Engineering Context

For the student-created video, the quantitative statements were:

- c. Participation in the video assignment improved my ability to analyze the potential impacts of the sustainable development goals
- d. Participation in the video assignment improved my ability to evaluate the importance of water engineering with respect to the Sustainable Development Goal in an Engineering Context

Students were asked to answer qualitative questions relating to the acquisition of knowledge from the assessments.

For the in-class debate they were asked

- e. Why are the sustainable development goals important?
- f. Outline what you have learned from the debate

While the student-created video questions were:

- g. Why is the sustainability of water important?
- h. Outline what you have learned from this assignment

3 RESULTS

3.1 Linking the SDGs to the Module Descriptor

It can be seen from Table 1 that some SDGs may seem more relevant than others but all related SDGs as per the matching exercise are being initially included. Following this, the targets of the goals selected are included so that targets/goals most related to the module’s learning outcomes can be examined.

Table 1. Linking SDGs with keywords of Environmental Engineering Module

Module Keywords	Related SDG	Target
Access to clean water and sanitation	SDG3: Good Health and Wellbeing	3.9
Affordable drinking water, clean water, contaminated, improving water, Inadequate water, infrastructure, Rivers, sanitation, sewage, sustainable water management, sustainable	SDG6: Clean water and sanitation	6.3, 6.4, 6.5, 6.6

withdrawal, water resources management		
Sustainable consumption	SDG8: Decent work and economic growth	8.4
Pollution, waste, solid waste, waste management, Water	SDG11: Sustainable cities and communities	11.6
Waste, water, water pollution, water supply, reduce-reuse-recycle.	SDG12: Responsible consumption and production	12.2, 12.4, 12.5
Climate change	SDG13: Climate Action	13.3
Fish, biodiversity	SDG14: Life below Water	14.1, 14.2

This exercise highlighted the broad range of the SDGs which were encompassed in the module which led to the use of the in-class debate to incorporate as many of the SDGs as possible. The student-created video was used to focus on SDG 6 while encouraging students to incorporate the other goals where relevant.

3.2 Student Perspectives on assignments

There were 37 responses to the in-class debate survey while there were only 17 responses to the student-created video questionnaires.

Overall, Statistical analysis of the quantitative statements in the survey showed that students perceived that there was an improvement in their critical thinking skills. A score of 4 on the Likert scale represents “Neither agree or disagree”. Any value above this is leaning towards “agree”. All of the mean values for the statements analysed were above 4. Responses to statements a. and b. in relation to the in-class debates above both generated a mean of 5.2. For statements c. and d. in relation to student-created videos were slightly lower at 4.8 and 4.7 respectively. These results suggest that students perceptions were that their analytical and evaluation skills relating to the SDGs generally, and specifically with respect to water sustainability were improved by participation in both the in-class debate and the student-created video assignments respectively.

The main theme that emerged from the qualitative statement e. Why are the sustainable development goals important? in relation to the in-class debate was

“future” (13 instances). Other themes were “life” (5 instances) and “planet” (8 instances).

For statement f. Outline what you have learned from the debate the interconnectedness of the goals was evident from multiple responses. One example stated:

“Each goal is unique but effect each other. They are all inter-linked”

The recurring themes in response to the question g. Why is the sustainability of water important? relating to the student-created video were “future” (7 instances) and “protect” (2 instances) and “health” (2 instances). The overall lesson learned appeared to be that the sustainability of water was important in order to protect health in the future.

Responses to h. Outline what you have learned from this assignment (video) demonstrated an understanding of the importance of water treatment:

“I have learned a lot about water treatment planrs (sic) and the importance of water.”

An awareness of the importance of protecting water was also demonstrated:

“There are many ways to protect the water environment however a lot of investment and planning is required”

Qualitative analysis of responses shows a frequent occurrence of the words found in the mapping of the SDGs exercise.

4 SUMMARY AND ACKNOWLEDGMENTS

In summary, this work has been very useful in informing the assessment of ESD. Student perspectives demonstrated that they felt that they had developed critical thinking skills by participating in the student-created video and more so, in the in-class debate.

The initial use of an innovative formative assessment was useful in developing students collaboration and communication skills. It also provided the educators with confidence in the students’ SDG knowledge to complete the summative student-created video assignment.

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