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Una Beagon, Klara Kövesi, Brad Tabas, Bente Nørgaard, Riitta Lehtinen, Brian Bowe, Christiane Gillet, Claus Spliid

### ► To cite this version:

Una Beagon, Klara Kövesi, Brad Tabas, Bente Nørgaard, Riitta Lehtinen, et al.. Sustainable Development and the SDGs: Revealing Engineering Academics, Students and Employer Viewpoints. SEFI 2021 Annual Conference, Sep 2021, Munich, Germany. hal-03469154

**HAL Id: hal-03469154**

**<https://ensta-bretagne.hal.science/hal-03469154>**

Submitted on 19 Jul 2022

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# **SUSTAINABLE DEVELOPMENT AND THE SDGS: REVEALING ENGINEERING ACADEMICS, STUDENTS AND EMPLOYER VIEWPOINTS**

**U Beagon**

TU Dublin

Dublin, Ireland

ORCID: 0000-0001-6789-7009

**K Kövesi**

ENSTA Bretagne

Bretagne, France

ORCID: 0000-0002-4036-6475

**B Tabas**

ENSTA Bretagne

Bretagne, France

**B Nørgaard**

Aalborg University

Aalborg, Denmark

**R Lehtinen**

Metropolia University of Applied Sciences

Helsinki, Finland

**B Bowe**

TU Dublin

Dublin, Ireland

**C Gillet**

ENSTA Bretagne

Bretagne, France

**C Spliid**

Aalborg University

Aalborg, Denmark

**Conference Key Areas:** *Sustainability, Curriculum Development*

**Keywords:** *Conceptions of Sustainable Development, Awareness of SDGs*

## **ABSTRACT**

As the world's focus turns to the future and not the present, the engineering profession must respond to the ever increasing need to bring about a sustainable future. The objective of this paper is to support the reform of engineering education by acknowledging and building upon the current awareness and understanding of sustainable development held by key stakeholders in the process.

This paper presents the outcomes of a study involving twelve focus groups with Academics, Employers and Students in four European countries (Denmark, Finland,

France and Ireland) as part of the A-STEP 2030 European Project. Based on the findings, it is clear that the key stakeholders closely associate the theme of the environment with Sustainable Development. There is also mention of the pillar of economy, but less so, that of society. The findings also reveal differences in the awareness of specific Sustainable Development Goals (SDGs), with SDG 13 (Climate Action) being most widely noted. The findings allow educators to engage in discussion with students to build a more complete understanding of aspects of sustainable development and to act in redesigning curricula to ensure engineers can contribute to a sustainable future.

## **1 INTRODUCTION**

During the last decade, there has been an increasing interest in research on the importance of sustainability in engineering education [1]. The literature highlights the central role of the engineering profession in the achievement of the SDGs: future generations of engineers will not only be catalysts of technical innovation but will also play a leading role in addressing various social issues [2].

It has been argued that sustainability and sustainable development are concepts that are difficult to define, even that they “mean all things to all people” [3]. As other observers have noted [4] the nature and meaning of the concept of sustainability and sustainable development have been hotly debated. A definition that is frequently quoted and held as affirmative (eg. [5]) comes from the World Commission on Environment and Development, which defines sustainable development as development that: “meets the needs of the present without compromising the ability of future generations to meet their own needs” [6, p.39]. Regardless of these differences in conception and discourse, sustainable development is usefully analysed via the “three pillars model” of sustainable development (also called the three circles model [7] or the Triple Bottom Line [8]). The three pillars of sustainability are: environmental, social, and economic.

Further recognition of the importance of sustainability was accorded when the UN chose to include the “preservation of the environment” in its 2000 Millenium Development Goals. In 2015, the MDGs became the SDGs or Sustainable Development Goals, a shift in language that affirms that all real development must be sustainable. Hence as engineering educators we can support educational reform by preparing our students to achieve the SDGs and to do so we must appreciate and expose our students to the three pillars of Sustainable Development.

Reform of engineering education to address these sustainability challenges will only be successful when educators have an opportunity to reflect on their conceptions in order to find potential pathways to change. The purpose of this study was to gain an insight into the viewpoints of engineering students, academics and employers in relation to their understanding of Sustainable Development and in particular to their awareness of the SDGs.

Specifically, the study sought to answer two questions:

1. To what extent are employers/academics/students aware of the concepts of Sustainable Development (SD)?

2. To what extent are employers/academics/students aware of the Sustainable Development Goals?

## **2 METHODOLOGY**

### **2.1 Context**

It is important at this point to provide overall context for the study, before focussing on the specific research questions presented in this paper. The focus groups which are described in more detail in the next section were split into three parts. The first part focussed on the concept of Sustainable Development and participants were invited to brainstorm the themes associated with Sustainable Development. The purpose of this part was to give context to the differing conceptions of Sustainable Development by the participants, as this may affect how they answered follow on questions. The second part of the focus group aimed to investigate the awareness of the SDGs in general and of specific SDGs in particular and finally, participants were invited to discuss the skills required of engineers of the future in order to achieve the SDGs. The outcomes from the first two parts are the focus of this paper.

For the final part, we wished to generate conversation, including brainstorming sessions and discussion and debate on the topic which revealed the differing understandings from each stakeholder group. Hence, a qualitative research approach was employed [9] and focus groups were selected as the most appropriate method of inquiry to investigate complex questions through direct interaction with participants.

As the intention was to compare the results of each participant group across countries it was important that the outline for how the focus group was to be carried out was agreed between all academic partners. To this end, a Focus Group Instructions document was created and was reviewed and agreed by all parties. It is important to note that focus groups in each country were facilitated within their native language, digitally recorded and partially transcribed and only selected citations were translated into English by each partner organisation. It is important to highlight this as a limitation of the work, as the frequency word lists were then formed from translated concepts and terminology. Each partner created a report summarising the findings of the focus groups in each country, using an agreed report template. This was forwarded to the lead partner in this activity and the results were collated.

Twelve focus groups were organised with participants from key stakeholder groups (academics, students and employers) in each of the four participating countries. Invitational emails were sent to academic staff and students in each partner institution and employer groups were recruited through invitation emails sent from either professional organisations in each country or through alumni contacts. There was no sampling criteria applied as all respondents were selected to take part. In total, there were 86 participants who engaged in 2 hour focus groups as part of this study (between March and July 2019) and demographic information is included in Table 1. As the research work involved human participants, ethical approval was granted by TU Dublin and researchers in each country also gained ethical approval for focus groups within their respective universities.

*Table 1: No of focus group participants and level of expertise*

	<b>No of Students and no of years of study</b>	<b>No of Academics and academic experience</b>	<b>No of Employers and length of experience</b>
<b>Ireland</b>	7 1-5 years	9 1-20 years experience	6 1-41 years experience
<b>France</b>	9 3-5 years	7 2-20 years experience	8 2-49 years experience
<b>Denmark</b>	7 1-5 years	8 2-40 years experience	6 20-35 years experience
<b>Finland</b>	4 2-3 years	8 8-24 years experience	7 15-37 years experience

## **2.2 Data collection and analysis**

In specific relation to the first research question addressed in this paper, participants were asked individually to brainstorm the words or themes they associated with Sustainable Development and these terms were collected and collated for each stakeholder group in each country. The words/themes associated with Sustainable Development (SD) were analysed using word frequency analysis. It is important to note here that phrases were separated into individual words in order to cut down the number of variations available. So for example a phrase such as “Renewable Energy”, would be counted as both “renewable” and “energy”. Whilst this gives a representative response to this term, it is also important to note that the context of the word should also be considered, for example “Circular” was normally used within the phrase “Circular Economy”.

Participants were then also asked individually, if they could name any of the SDGs, without the researcher giving any introduction as to what the SDG goals were. This was also an individual exercise. Responses were collected, analysed and tagged to the relevant SDG where appropriate. Some participants gave specific responses which were easy to identify such as “Clean Water” (tagged as SDG 6) or “To make cities safe, inclusive and sustainable places” (tagged as SDG 11). Others gave responses which were interpreted and tagged to two different SDGs such as “To provide education to people in the 3rd world” which was tagged as SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities). Finally, seven responses were not deemed to be related to a specific SDG (although they reflected the concept of SD) and were therefore not tagged. These were; “Sustainability and long term vision”, “Environmental Poverty”, “Security”, “Synergy of human being and nature”, “Sustainable awareness building”, “Technical” and “Social”.

## **3 RESULTS**

Table 2 shows the frequency of the most highly ranked individual words to identify the themes associated with Sustainable Development, which also corresponds to Figure 1. Only those words with a frequency of 10 or more are included here.

*Table 2. Frequency of most highly mentioned words by stakeholder group*

Term used	Overall Frequency	Academics (Frequency)	Employers (Frequency)	Students (Frequency)
Energy	65	29	23	13
Environment	30	10	8	12
Renewable	30	12	9	9
Recycle	28	10	9	9
Economy	26	12	8	6
Reduction	22	11	6	5
Waste	20	7	5	8
Clean	20	13	5	2
Consumption	17	7	6	4
Resources	17	11	4	2
Education	14	6	3	5
Water	14	10	3	1
Efficiency	13	5	6	2
Green	12	7	3	2
CO2	12	6	5	1
Sustainable	11	6	3	2
Materials	10	7	1	2
Circular	10	4	5	1
Climate	10	3	5	2



Figure 1: Word cloud showing all words and themes associated with Sustainable Development [All countries, All groups]

The results for each participant group were also analysed to contrast and compare different groups. Figures 2-4 shows the individual word clouds associated with Sustainable Development with each participating stakeholder group.



*Fig. 2. Academics – themes associated with SD*



*Fig. 3. Employers– themes associated with SD*



*Fig 4. Students– themes associated with SD*

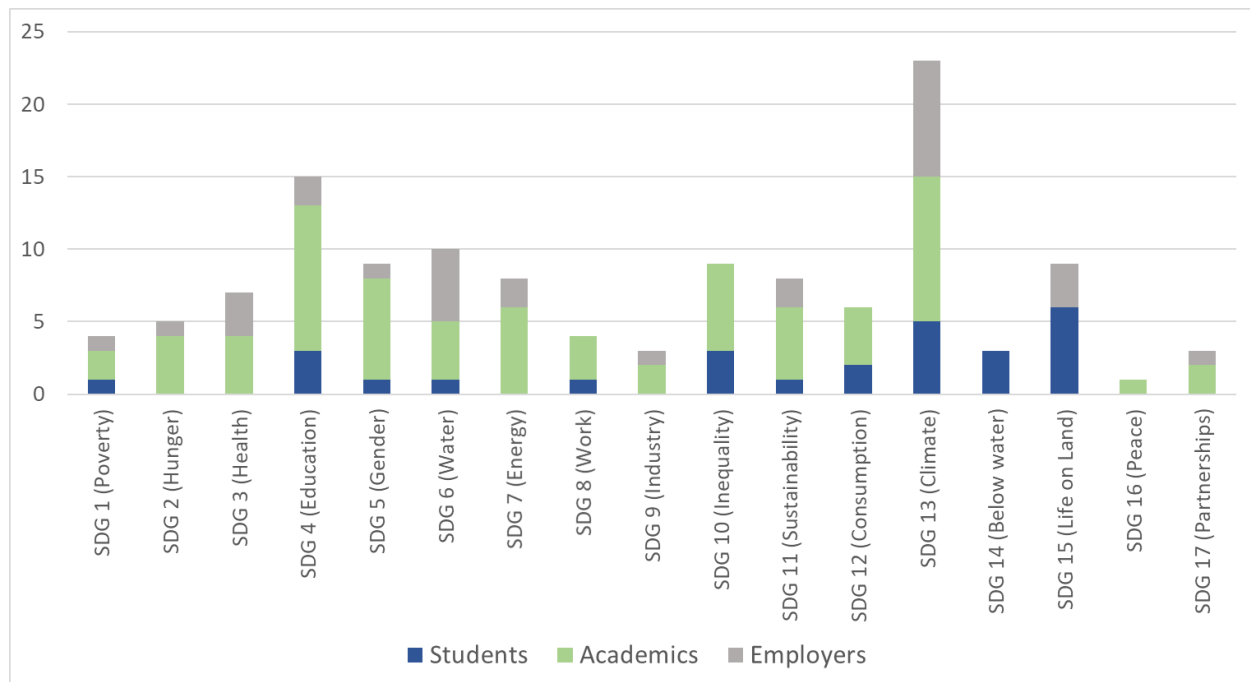
The overall results of the word frequency exercise presented here suggest that “Energy”(65) is the key theme associated with Sustainable Development, clearly out in front and followed by “Environment”(30), “Renewable”(30) and “Recycle”(28). These key words align very clearly to the pillar of Environment. “Economy”(26), “Resources”(17) and “Circular”(10) are the most mentioned words associated with the pillar of Economy. Words associated with the third pillar, Society, are sparse, with only “Education”(14) and to a lesser extent “Diversity”(5) and “Equality”(5) being included within this pillar, but with only five mentions each.

The picture when we look at key stakeholders tells a similar story, with Energy, Renewable and Environment standing out clearly in all groups. With regard to comparison of student groups across countries, in France, the use of words “Education” and “Management” in relation to SD stands out. Management in this context was mainly used in phrases such as “Waste Management”, “Forest Management” and “Energy Management”.

The academic groups brought the concept of “Clean” to the fore compared to employer and student groups. Comparing between countries showed differing foci with Irish academics concentrating on “Renewable” “Energy” and “Water” and offering words associated with specific technical solutions to SD, such as “Heat Source pumps” “Ground Source pumps” and “Rainwater harvesting.” French academics brought out the idea of “Consumption” and “Resources” as a key theme.

Employers placed more emphasis on “Efficiency” compared with academics or students. In particular, Irish employers associate SD with the “Future” along with themes such as “Carbon” and “Efficiency. French employers highlighted the word “Consumption” but also reflected the words “Global” and “Respect (of nature)” which was not typical of other employer groups. The words “Transport” and “Infrastructure” and “Urbanisation” also appeared with Danish employers and there was a focus on “Circular”, “Economy”, “Technology” and the “Future” with Finnish employers.

In regard to the second research question, we sought to investigate the awareness of the SDGs in general and of particular specific SDGs. Figure 5 shows the differentiation in which particular goals were most often identified, indicating the level of general awareness of each individual SDG. This figure also shows the number of goals identified by each participant group.



*Figure 5: No of mentions for each SDG by participant group.*

SDG 13 (Climate Action) tops the list with the greatest number of mentions (23), and far exceeds other goals. With 15 mentions, SDG 4 (Quality Education) comes in second place, followed by SDG 6 (Clean Water and Sanitation) with 10 mentions. Perhaps surprisingly, SDG 5 (Gender Equality) comes in fourth place, along with SDG 10 (Reduced Inequalities) and SDG 15 (Life on Land). These particular SDGs (5 and 10) relate to the wider concepts of the SDGs, or align to the societal pillar of SD. Students did not identify SDG 2 (Zero hunger) nor SDG 3 (Good Health and Well Being), whilst both were identified by Academics and Employers, perhaps reflective of the older age profile within these groups.

#### 4 DISCUSSION AND IMPLICATIONS

Due to space considerations, this paper presents only a snapshot of the findings within the focus groups. More detailed results including detailed differentiation between each stakeholder group and each country (including the influence of governmental policies) can be found in the full project report [10].

The findings concur with previous studies on the lack of awareness of the pillar of society in conceptions of SD [11] and the lack of mention of terms associated with the social pillar in a study on the understanding of “global responsibility” from engineers working in industry [12]. This highlights the need for educators to enhance the engineering curriculum to bring forth the social aspect of SD, as a combination of all three pillars are needed to really achieve a sustainable future.

More specifically, the findings highlight three implications for learning and teaching in engineering education. The first is by acknowledging the differences in each stakeholder group in relation to what we mean by Sustainable Development. Students are focusing on terms such as “recycle” and “waste” more so than academics. This is perhaps due to the updated curriculum being taught at primary level in recent years in relation to the environment and climate action. This should encourage engineering educators to generate discussion amongst students in



relation to the three pillars of Environment, Economy and Society so that a more complete understanding is reached by all.

The second is by looking at the gaps or differences between stakeholder groups in relation to awareness of specific SDGs. For example, academics approach the classroom with an awareness of SDG 2 (Zero Hunger) and SDG 3 (Good Health and Wellbeing), yet students are unaware of these SDGs. Finally, the overall awareness of specific SDGs may indicate that engineering educators should turn their focus to goals such as SDG 16 (Peace, Justice and Strong Institutions) as one SDG that needs more attention in the classroom, whereas SDG 13 (Climate Action) may need less initial focus as it appears that academics, students and employers have a clear focus on the aspect of climate action and environmental change.

## 5 ACKNOWLEDGMENTS

This work was supported by EU Erasmus + and funded under call number 2018-1-FR01-KA203-047854. The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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