Engineering Skills to Respond to SDGs: A Survey of Employers, Academics, and Students

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Abstract: Addressing challenges posed by the Sustainable Development Goals (SDGs) will require the next generation of engineers from all disciplines to be equipped with specific skills. Given this context, a professional skills survey was designed, drawing on previous European-level research. Its results provide valuable localised insights for educators into the most important skills for the next generation of engineers (on the island of Ireland) to achieve the SDGs. They also reveal some variance in the views of employers, academics, and students.

Keywords: education; competences; SDGs; sustainability

1. Introduction

The professional skills required by engineers have been the subject of much research, generally at national or international levels [1–4]. More specifically, influential work conducted by Wiek et al, de Haan and Rieckmann [5–7] considered the skills required for sustainable development.

A recent European study [8] narrowed the focus further to competence requirements for engineers to support the achievement of SDGs. It presented 53 competences in six main categories, though it reported a lack of agreement on which competences should be prioritised.

This paper contextualises the 53 competences on a smaller scale (national, regional). It explores and compares stakeholder perspectives on the specific professional skills required for engineers in the context of achieving the SDGs.

This seeks to inform future educational initiatives, bearing in mind the UNESCO (2017) report “Education for Sustainable Development Goals: Learning Objectives” [9], which provides a framework for educators to enhance their curriculum, offering students an opportunity to develop much-needed skills required for the future. However, educators could feel overwhelmed by a list of 53 competences. So, identifying contextually relevant priorities could prove useful in informing educational initiatives in individual universities.

2. Methods

2.1. Context for the Research

This research was conducted as part of a Higher Education Authority (HEA) funded project entitled PROFESS 12.

2.2. Approach

A professional skills survey, developed using MS Forms, was based on previous research [8], which identified (at the European level) the skills that engineers needed to meet the SDGs. Ethical approval for this survey was granted by the Research Ethics and Integrity Committee in TU Dublin (REIC-21-74). The survey (piloted prior to launch...
(November 2022)) requested information on respondent profile capturing characteristics such as category (academic/employer (including sector, size)/student (including year)) and demography (gender, age, region). The first question seeking stakeholder perceptions explored awareness of the SDGs. Further questions sought ratings on the importance and preparedness of engineering students and graduates and then priorities for teaching with reference to the 53 competences identified in six competency sets [8]. Finally, an open-text response was provided for additional feedback (if any). Invitations to participate in the survey were issued (primarily via email) to students in TU Dublin and Ulster University; academics in the research team’s personal networks (wider than TU Dublin and UU); and engineering employers in the research team’s personal networks and through professional institutions (such as Engineers Ireland and Institution of Structural Engineers).

This paper describes findings on awareness of SDGs and the importance of the competences only. Analysis of survey responses by category of respondents (academic, employer, student) has been undertaken to examine which competences are rated most important by category. It does not further differentiate by region nor by gender, though views are likely to differ within some if not all, sub-groups. This could form the basis of further research and analysis. Some other aspects of analysis are considered elsewhere: another paper [10] based on the same primary research (survey) considers findings disaggregated by region rather than by category of respondent.

3. Results

Key findings are presented below, with initial consideration given to the profile of respondents.

3.1. Profile of Respondents

Of 235 survey respondents, slightly over one-third were from Northern Ireland (n = 88), with most being from Ireland (n = 147). A small number of responses (n = 7) from elsewhere were excluded from this analysis. Students provided the most responses (over half, 54.9%) and academics almost one quarter (23.0%). Employers (mostly multinationals and SMEs (8.9%) and nationals (4.3%)) provided the remainder of the responses.

3.2. Awareness of Sustainable Development Goals (SDGs)

Overall awareness of the SDGs measured on a five-point Likert scale (from 5—extremely aware to 1—not at all aware) was 3.2 (somewhat to moderately aware). However, awareness was not consistent within categories: unsurprisingly, the highest (4.1) was amongst academics. Awareness amongst all employer categories was markedly lower: 3.3 for multinationals and nationals. The lowest levels of awareness were amongst SMEs and students (2.8 each).

3.3. Importance of Competences

Respondents rated importance on a five-point Likert scale (from 5—very important to 1—not important) for 53 competences in six competency sets. All are rated as being of at least some importance, with an average rating of 3 or more. The five most important competences (Table 1) overall had ratings greater than 4.5.

Disaggregating results by category (Table 1) shows that whilst the competences ranked as the most important are broadly similar, there were also notable differences in rank order and in the inclusion/exclusion of certain competences in each category. Ten different competences are featured across all categories. In most categories, there are more than five competences in the top five rankings, as some competences share average importance scores.
Table 1. Importance of Competences by Category—Ranked 1–5.

<table>
<thead>
<tr>
<th>Category</th>
<th>Top 5 Most Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic</td>
<td>1 = Problem Solving; 2 = Teamwork / 2 = Critical Thinking; 4 = Respect for Others; 5 = Collaboration / 5 = Communication</td>
</tr>
<tr>
<td>Employer–Multinational</td>
<td>1 = Problem Solving / 1 = Communication; 3 = Respect for Others; 4 = Collaboration; 5 = Critical Thinking / 5 = Teamwork / 5 = Technical Skills</td>
</tr>
<tr>
<td>Employer–National</td>
<td>3 = Critical Thinking / 3 = Sustainability Awareness / 3 = Time Management</td>
</tr>
<tr>
<td>Employer–SME</td>
<td>1 = Problem Solving / 1 = Communication / 1 = Teamwork; 4 = Adaptability; 5 = Collaboration / 5 = Time Management</td>
</tr>
<tr>
<td>Student</td>
<td>1 Problem Solving; 2 Communication; 3 Respect for Others; 4 Teamwork; 5 Time Management</td>
</tr>
<tr>
<td>All</td>
<td>1 Problem Solving; 2 Communication; 3 Teamwork; 4 Respect for Others; 5 Critical Thinking</td>
</tr>
</tbody>
</table>

In Table 1, coloured font is used to illustrate similarities/differences between categories. Each competence is allocated a colour; its rank for each category is shown in the same colour. Three competences are shown in black font; each of these only appears once in the table.

4. Conclusions

Amongst survey respondents, there are interesting differences in awareness of SDGs. There is broad agreement on the most important competences required by engineers, but there are also notable differences. Although this is perhaps to be expected given the different environments in which academics, employers, and students operate, it is notable that some competences (Communication, Teamwork) feature in all employer categories' top five, whilst there are also distinctive competences for each employer type. Overall, this provides useful insights for academics to consider in engineering curriculum design and in managing students' expectations to reflect employer priorities.

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