



## WHAT IS THE ROLE OF ETHICS IN ACCREDITATION DOCUMENTATION FROM A GLOBAL VIEW?

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**ABSTRACT**

Ethics in engineering has long been an important element in engineering programmes, however these subjects are often taught at a basic learning level with little attempt to connect to demonstrative learning outcomes. In recent years there has been a step change in the importance of ethics as an integral part of engineering programmes and is reflected in the text of accreditation documents. In this paper we expand our analysis from an earlier study, which focused on four European countries, to understand the role of ethics on a more global scale. We conducted a multi-country analysis on how and where ethics features in accreditation documents in twelve countries across five continents (Belgium, Canada, Colombia, France/Switzerland, Ireland, Japan, Romania, South Africa, Sweden, UK and USA). We identified explicit or implicit references to ethics education, extracted verbs relating to learning outcomes, and compared definitions of key terms. A comparison to Bloom's taxonomy showed considerably higher frequency of verbs linked to ethics teaching associated to lower levels of cognitive learning. Definitions of terms relating to the process of accreditation were often lacking in documents, highlighting a need for setting terms of reference. This study highlights differences in how ethics is described in accreditation documents. However, more needs to be done to explicitly highlight ethics as an integral part of engineering education. Relying on implicit links to ethics leaves the role of ethics open to interpretation, resulting in uneven emphasis in the translation of ethics within programme designs.



## 1 INTRODUCTION

### 1.1 Background

Globally, engineering accreditation programmes identify specific areas of knowledge and skills that need to be addressed in order for students to qualify as engineering graduates. Historically, the main focus has been on specific areas of scientific, mathematics and engineering knowledge with little detail with regards to ethics. In recent years there has been a step change in highlighting the importance of ethics as an integral part of engineering programmes, which often is reflected in accreditation documents. Examples of this renewed focus include the significant change in UK Engineering accreditation by the Engineering Council launched in 2020 [1], as well as shifts in the Australian accreditation documents[2]. While this is a positive step, our previous research[3] indicates that more work is needed at the policy level to explicitly integrate ethics across engineering programmes, particularly in the way learning outcomes are written and demonstrated.

### 1.2 Study Aim and Research Questions

The aim of this study is to explore how engineering ethics is portrayed in engineering accreditation documents and observe trends or differences in a multi-country global analysis. We address three research questions:

- 1) What key terms are defined and how do they compare across documents?
- 2) What learning outcomes are specified implicitly and explicitly that refer to ethics?
- 3) What verbs are used in learning outcomes that refer to ethics and which levels of cognitive learning do they represent according to Bloom's taxonomy?

## 2 METHODOLOGY

A multi-country analysis was carried out on the accreditation documents of twelve countries: Belgium, Canada[4], Colombia[5], France/Switzerland[6,7], Ireland[8], Japan[9], Romania[10], South Africa[11], Sweden[12], UK [1] and USA[13]. For Switzerland, only the French Swiss region was reviewed, where the same accreditation document is used as in France, thus covering both countries. Belgium does not have national, discipline-specific engineering accreditation therefore the engineering programmes can be accredited via the procedure in other countries, such as the French speaking region aligning with the CTI French accreditation document. Therefore, ten accreditation documents were analysed for the study. The competencies, learning outcomes and program outcomes where appropriate were reviewed and the analysis was divided into 3 sub-sections that align to the 3 research questions outlined below.

### 2.1 Classification of key terms

We identified and extracted all definitions of key terms in the accreditation documents that are related to programme content or content delivery, such as "learning outcomes", "higher education" and "accreditation". Where terms were

defined in two documents or more, we performed a qualitative comparison of the different definitions. This analysis was done to help identify any contextual or interpretive differences in definitions, which may influence how ethics is viewed, taught and evaluated from the learning outcomes that were evaluated in this study.

## 2.2 Explicit and implicit references to ethics education

Although the general method was consistent, due to the large variety in scope and structure between different accreditation documents, the method applied was adapted on a case by case basis to accommodate different documentation formats as outlined in the appendix. To analyze *explicit references to ethics education*, we first counted how many times the terms “ethics” and “ethical” were used in the respective documents. We then extracted all the learning outcomes in relation to these terms for verb analysis (next section). To analyze *implicit references to ethics education*, we first developed a set of reference terms that are used in engineering ethics education. For this purpose, we extracted key words and topics related to ethics from the table of contents of 5 textbooks (Fig. 1) as described in the previous study[3]. A quantitative word analysis was carried out in order to identify the use of these common terms in the accreditation documents.

## 2.3 Analysis of verbs used in ethics-related learning outcomes

Verb usage was analysed in three steps: First, we identified all verbs in learning outcomes that are related to the terms “ethics” or “ethical”. For example, in the phrase “demonstrate awareness of ethical aspects”, we identified “demonstrate awareness” as a verb related to ethics learning. Second, we categorized all identified verbs as either *action verbs* (doing), *cognitive verbs* (thinking) or both. Third, a comparison was carried out on the use of these verbs according to the hierarchical learning levels from Bloom’s taxonomy of learning.

# 3 RESULTS

## 3.1 Classification of key terms

A total of 22 terms were defined across 10 documents. Only five terms were found defined in three or more documents: “Accreditation” and “Learning Outcomes” (both terms in 6 documents), “Graduate Attributes”, “Knowledge” and “Understanding” (each term in 3 documents). The remaining terms occurred only once or twice as shown in Table 1.

What is not clear from the frequency of the use of specific terms across documents is how the use of terms can vary across contexts. For example, the term “accreditation” can refer to processes of quality assurance for engineering programmes that include formal assessment of compliance to existing standards, peer review by stakeholders regarding program quality, or both. Similarly, “learning outcomes” are defined in relation to different contexts, such as the programme of

study (Colombia/UK AHEP4) or the process (France/Bel CTi/Switzerland). Furthermore, “learning outcomes” can include “knowledge” and “skills” (UK, USA, Colombia), “competence” (France), “values” (UK), and “approach” (Sweden) or they can be used to specify “graduate attributes” (South Africa).

Table 1. Word list highlighting most common terms of reference in 10 documents from 12 countries showing the most commonly defined in red.

Terms Defined	No. of documents	Terms Defined	No. of documents
Accreditation	6	Learning outcomes	6
Assessment	1	Module	1
Competence	1	Pathway	1
Delivery	1	Programme educational objectives/ Programme Outcomes	1
Engineering design	2	Programme/Program	1
Evaluation	1	Responsibilities of engineering practice	2
Graduate attributes	3	Skill	2
Higher Education	2	Societal context	2
Higher Education Institution	1	Student	1
Know-how	1	Transferable skills/ Complimentary skills	2
Knowledge	3	Understanding	3

### 3.2 Explicit and implicit references to ethics education

The terms “ethics” or “ethical” were only *explicitly* mentioned in learning outcomes or programme outcomes between 2 and 10 times across documents (average  $4.5 \pm 2.2$  SD). In contrast the *implicit* terms were found between 6 and 187 times (average  $77.5 \pm 62.1$  SD). The explicit terms will be expanded in section 3.3 on verb-usage.

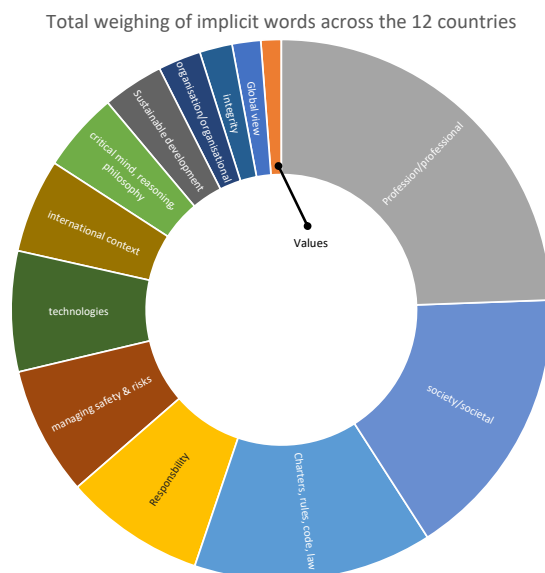


Fig. 1. Weighted frequency with which implicit reference terms are used, showing high representation of terms such as “professional” and low representation of terms such as “integrity” and “values”.

Our analysis of terms associated with *implicit* references to ethics showed that the frequency with which the top five terms were used corresponds to more than 70 % of all implicit terms were used (Fig. 1), these were: “Profession”, “Society”, “Codes/Laws”, “Technologies” and “Responsibility”. Conversely, four of the five least used terms constitute less than 6 % of all occasions of term usage: “Global views”, “Organisation”, “Integrity” and “Values”. Finally, “Justice” was not used in any of the analyzed documents.

### 3.3 Verbs used in ethics-related learning outcomes

Among verbs *explicitly* related to ethics learning, we found a strong emphasis on *cognition* and less on *action* verbs (Fig. 2).

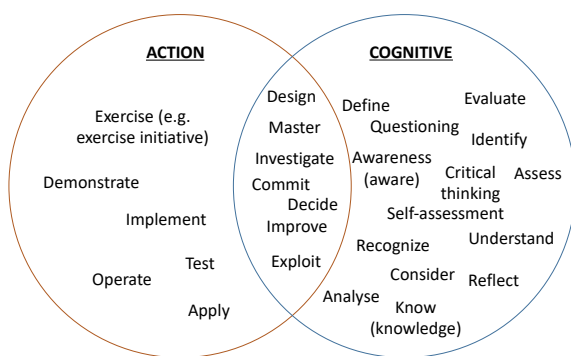


Fig. 2. Verbs related to explicit references to ethics learning that are used in the included accreditation documents.

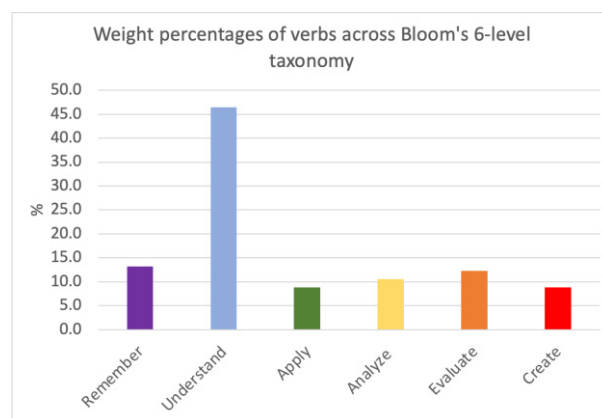


Fig. 3. Weighted percentage of verbs in learning outcomes relating explicitly to ethics shows high representation in the lower levels of learning according to the Bloom's taxonomy model.

Comparing the verbs (including both action and cognition) to Bloom's six levels of cognitive learning, we found that verbs relating to learning outcomes at all levels are included, however, verbs related to the second level (“understand”) clearly dominate in all documents (Fig. 3). While a peak is expected at the lower levels of learning, there was no trend showing a gradual transition to higher levels of cognition from “Understand” to “Create” (Fig. 3).

## 4 DISCUSSION

The aim of this study was to explore how engineering ethics is portrayed in engineering accreditation documents and observe trends or differences in a multi-country global analysis. The definition of terms provides context to the terms used in the documents. Currently the lack of common definitions potentially leaves room for



ethics to be differently defined, perceived and actualised in the engineering programmes of the different participating countries. The most common terms that were found across 6 documents were “Accreditation” and “Learning Outcomes” allowing some comparative analysis. However, the remaining terms were either found once, twice or thrice across all 10 documents reviewed. This made a comparison of terms not always possible for terms such as “assessment” (USA and South Africa) and “competence” (France, UK, Ireland, Colombia). Furthermore, in the case of South Africa, there was an emphasis on definitions for technical, rather than educational terms. For Canada, the definition of terms were removed in 2021 and made accessible elsewhere. In this instance, they were not relevant to programme development but rather to the accountability of roles in the accreditation process. The implications of differences in the definitions of terms is that some national accreditation documents have international reach and have been used as a benchmark for other countries, such as ABET (US), which accredits programmes in 41 countries, using an identical process for all. This wider reach makes these terms open to varied, and perhaps unintended, interpretations and affects how the terms are applied in programme development. With this in mind, accreditation bodies could bring into focus the terms they use and what they mean as part of their ethical due diligence in the construction of engineering programmes across a range of countries where the context or intended meaning of the learning outcomes as stated might otherwise be missed.

The explicit and implicit analysis of terms reflects that ethics is still marginal to the curriculum compared to other subjects. A more common language in other technical areas of the curriculum where terms and context are well-defined and understood. This is in contrast to the varied vocabulary found in the implicit terms identified in this analysis. Making this transnational comparison is important as student are mobile when they graduate and may be required to undergo legal processes for their degrees to be formally recognised. The implicit terms identified demonstrated a lack of pattern between countries or even between regions, other than the observation that the better represented ethical topics are ones that directly impact technical instruction such as “technology”, “profession” and “responsibility”. This lack of commonality is of interest and perhaps suggests no rigorous discussion on ethics from a regional level as compared to the technical subjects in engineering. This raises the question as to whether there should be a transition to a more common agreed language for ethics education in engineering.

The low profile of non-demonstrable aspects of ethics education is shown by the low emphasis on terms such as “Values”, “Integrity” and “Justice”. A focus on these terms may require a specific framework as a benchmark for the analysis of ethics education, such as that provided by the Rest Model[13], which identifies the four areas of ethical decision-making as Moral Awareness, Moral Reasoning/Judgment, Moral Intent and Moral Behaviour/Action. The Rest Model can be used to capture the



non-actionable aspects that are a pre-requisite to demonstrable skills and behaviours. For example, ethical motivation and ethical character links to integrity and values, which are largely missing from accreditation requirements. This suggests that ethical competence and a stepwise progression through ethical development may be missing and perhaps could be included at a policy level. This will be explored in the next phase of the study.

There are several limitations to the study. For practical reasons, we had to rely on a convenience sample, including countries based on the nationalities and associations of the participating authors. We focused primarily on differences in the linguistic formulation of policy across the included countries. As we do not aim to *explain* these differences, we did not engage in in-depth analysis of the different social, cultural, political and technological challenges across borders. Therefore, our analysis may indicate differences in how the responsibilities of the engineering professionals are represented in the accreditation documents, but these differences are not the focus of the analysis. We further assume that the inclusion of definitions of certain key terms in accreditation documents to some degree reflects what is considered relevant by the respective accreditation agencies.

Another limitation is the nuanced differences between methodological approaches, which was captured in the appendix. With such an overview the next stage is for quality control measures such as cross-checking the methodologies with a second reviewer to assess the true variation in approaches. The second limitation is the representation of regions. Europe is well represented (6 countries), whereas the remaining regions have very limited representation with only one document analysed in Africa (South Africa), Asia (Japan) and South America (Colombia). However, this is a preliminary study where our observations will feed into further inclusion of countries to be expected for the next stage in this study.

Further work will look to ensure a wider coverage of ethical topics in common use is considered, which may have been excluded from the list derived from text references, where a further exploration of alternative terms of association is planned. The authors also take this opportunity to invite researchers to join this study, particularly from countries in less represented regions (South America, Africa and Asia or Australasia) and encourage any interested parties to contact the corresponding author.



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## Appendix

The analysis process adopted for each of the documents; the range of approaches mirrors the high level of diversity in how documents are structured.

<u>Country</u>	<u>Methodology for quantitative assessment of words</u>	<u>Language</u>
Belgium	See France	n/a
Canada	Engineers Canada – Criteria and Procedures (complete document) <b>Excluded: references &amp; appendices.</b>	English & French
Colombia	Agreement 02 of 2020 – The National Council of higher Education – CESU	Spanish
France	CTI 2022 table of contents – Sections D-G <b>Excluded: remaining sections and references.</b> CTI 2018 Definition of Terms. <b>Excluded: remaining sections and references.</b>	French (2022) English (2018)
Ireland	Engineers Ireland Accreditation Criteria (complete document in English): Section 2 Definitions; Section 3.4 Programme Outcomes for Chartered Engineers <a href="https://www.engineersireland.ie/LinkClick.aspx?fileticket=Mz3SCCK_uRq%3d&amp;portalid=0&amp;resourceView=1">https://www.engineersireland.ie/LinkClick.aspx?fileticket=Mz3SCCK_uRq%3d&amp;portalid=0&amp;resourceView=1</a> <b>Excluded: remaining sections and references.</b>	English
Japan	JABEE Common Criteria for Accreditation of Professional Education Programs applicable in the year 2019 and later. JABEE Category- and Discipline-specific Criteria for Accreditation of Professional Education Programs applicable in the year 2019 and later <a href="https://jabee.org/en/accreditation/basis">https://jabee.org/en/accreditation/basis</a>	English translation
Romania	Specific standards for external evaluation of academic quality in undergraduate and master's degree programs – Engineering Sciences; Decision no. 915 of 14 December 2017 on amending the annex to Government Decision no. 1418/2006 for the approval of the Methodology for external evaluation, of the standards, of the reference standards and of the list of performance indicators of the Romanian Agency for Quality Assurance in Higher Education (original language for both documents: Romanian)	Romanian
South Africa	ECSA P-02-PE version 6 (full document)	English
Sweden	In the Swedish Higher Education Act, section 5 was analysed as it outlines general requirements for all higher education. In addition, in the Swedish Higher Education Ordinance, Annex 2, two sections referring to Engineering Bachelor and Master degrees, respectively, were analysed. <b>Excluded: remaining document and other documents that may contain additional definitions of key terms.</b>	English translation
Switzerland	See France	French
UK (AHEP-4)	The Accreditation of Higher Education Programmes (AHEP) 4 <sup>th</sup> Edition: Learning outcomes & definitions analysed. <b>Excluded: remaining document and references.</b>	English
USA	Criteria for Accrediting Engineering Programs, 2021 – 2022 Sections analysed limited to "Definitions" and "I. General Criteria for Baccalaureate Level Programs." <b>Excluded: remaining document and references.</b>	English