WHAT IS THE ROLE OF ETHICS IN ACCREDITATION GUIDELINES FOR ENGINEERING PROGRAMMES IN EUROPE?

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ABSTRACT

The Washington Accord emphasises the role of ethical and societal considerations in the practice of engineering. Increasingly, national accrediting bodies are also expecting to see evidence in the delivery and assessment of ethics throughout engineering programmes. Nevertheless, there is still little known on how the process of evaluating ethics can best serve the function of accreditation ensuring quality assurance and quality improvement. The aim of this paper is to look at the top-down approach and analyse what role engineering ethics plays in national accreditation documentations in Europe. A multi-country analysis of how and where ethics appears in the systems of accreditation was carried out for the UK, Ireland, France, and Switzerland. The competencies, programme outcomes or learning outcomes were reviewed and explicit or implicit references to ethics education were identified. A quantitative and qualitative word analysis was carried out by extracting verbs and comparing verb definitions that were stated. Verbs were categorised under Doing actions, Thinking actions or both and compared to Bloom's Taxonomy of Learning. In

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all cases, ethics was explicitly mentioned however limited to 1 or 2 sections of the documents reviewed. The majority of statements linking to ethics were implicit, opening room for interpretation. A more conscious effort to engage engineering ethics in all aspects of engineering programmes as well as using higher levels of Bloom's taxonomy should be made where engineering ethics education is applied in practice.

1 INTRODUCTION

1.1 Background

Currently engineering ethics is featured in a limited capacity in engineering programmes, however it is a subject that pervades every area of engineering and therefore needs more prominence in engineering programmes. Although there are practitioners on the ground advocating this change and communities of practice in engineering ethics that are gaining critical mass, we need to also look at a top-down approach and review how policies, in particular current accreditation documents, are advocating the education of engineering ethics. The aim of this paper is to look at the top-down approach and analyse how engineering ethics is taken into account in national accreditation documentations in Europe.

In light of this aim, there is a wave of change happening at the policy level, with the inclusion of ethical and societal considerations in the Washington Accord [1], which has contributed to the inclusion of ethics in the formulation of accreditation criteria for engineering programmes in signatory countries [2]. This in turn has impacted positively on the presence of ethics education in the engineering curriculum, through an increased content of ethics [3-6] and use of active learning methods in relation to this content [7].

Understandably, Higher Education Institutes rely on their respective national accreditation documents as one of their primary resources in programme content and development. With this reliance is a dependence on the use of language, definitions and how learning outcomes are structured, which in turn become key factors on how engineering is taught. In addition to the need to be more globally relevant, the different use of language and interpretations across borders becomes even more important. To date, no critical analysis has been carried out on how engineering ethics is featured in accreditation documents with respect to use of verbs and definitions and how these compare between countries. This will be the focus of this paper with a discussion on the implications of these findings.

1.1 Context of Engineering Ethics

In order to examine how ethics is treated in the standards of the engineering education accreditation bodies, we sought to establish a reference framework from which we could diagnose the situation of the required standards. We have constructed this frame of reference from four books aimed at educating engineers in ethics: Harris et al., 2009, Martin et al., 2010, Poel & Royakkers, 2011,

Fleddermann, 2012 [8-11]. To consolidate this approach, we have also taken into account a fifth book by Legault (2005) aimed at educating professionals more generally in ethics [12]. In addition to the expected concepts, this synthesis aims to bring out key words for the analysis of accreditation bodies' reference systems. Indeed, ethical know-how integrates different fields of knowledge, which can be addressed in the repositories, without appearing in a section entitled ethics.

2 METHODOLOGY

A multi-country analysis was carried out on the accreditation documents of four countries: UK [13], Ireland [14], France and Switzerland [15]. For Switzerland, only the French Swiss region was reviewed, where the France documentation was used to cover both countries. The official English translation of the CTI French accreditation document was used for the analysis. Therefore, three accreditation documents were analysed. The competencies, learning outcomes and program outcomes were reviewed and explicit or implicit references to ethics education were identified. A comparative quantitative and qualitative word analysis was carried out by extracting verbs and comparing verb definitions that were stated.

2.1 Identification of common terms used in engineering ethics

Classification of the main concepts, keywords and topics derived from the table of contents from five books specific to engineering ethics was carried out in order to identify a range of terms in current use [8-12] that were utilised in this study to carry out a word analysis of the accreditation documents as outlined below.

2.2 Ethics cited explicitly and implicitly

An analysis of the learning outcomes and programme outcomes across documents were analysed using six general categories: Dedicated Outcomes, Design, Management, General Skills, Technical and Organisational/Personal/Cultural. Under each category, it was identified wherever ethics was mentioned explicitly based on the terms “ethics” and “ethical”. Implicit association of ethics was carried out by using the common terms identified from the texts chosen (Section 2.1).

2.3 Analysis of verb usage in learning outcomes cited on ethics

Verbs were categorised under Doing actions, Thinking actions or both and compared to Bloom’s Taxonomy of Learning. A comparison was carried out on the use and frequency of these verbs according to the hierarchical learning levels.

3 RESULTS

3.1 Classification of terms in engineering ethics

The range of common terms were collected from the 5 texts on engineering ethics as shown in Table 1. These common terms were extracted from the contents page and collated to highlight the range of terms that were used in identifying subjects that implicitly relate to engineering ethics. The sub-topics also covered very broad subjects and terms that were not included for brevity such as “decision”, “cultural”,

"social" and "policy", which are not found in this list but covered under these main topics as shown in the examples.

Table 1. Terms in use from 5 textbooks on engineering ethics from contents list.

Main topics	**Examples**
Ethics global point of view	Why teach ethics to engineers, professional vs personal ethics.
Ethical values	Golden rule, universal principles such as integrity etc.
Profession and professionalism	Ethics of corporation, engineers responsibility.
Responsibility	Active or passive actions, links with standards and codes.
Charters, rules, codes, law	Characteristics, preventative measures and limits.
Understanding ethical problems, developing a critical mind and ethics reasoning: philosophy of ethics	Normative ethics, values, dilemmas and moral choices and decisions.
Solving ethical problems	Design of ethical solutions, ethical deliberation.
Engineer working in organizations	Organizational loyalty, whistleblowing, policies.
Engineer managing safety and risks	Engineer's responsibility for safety, cost/benefit/risk analysis, Health and Safety, Risk Assessments.
Engineer and sustainable development	Environmental ethics, sustainability, circular economy.
Engineer in international context	Non-western thinking, global codes for multinational, multilingual and multiethnic considerations.
Engineer and research integrity	Research integrity, truthfulness, trustworthiness, reliability.
Engineer and digital technologies	Ownership of computer softwares, IPR, financial exploitation, data protection.
Engineer designing technology	Ethical issues during the design process, data protection.
Global justice	Technology transfer and appropriate technology, social equity vs social disparity, governance and policies.
Ethical issues, dilemmas and case studies	Extortion, bribery, many hands responsibility, systematic errors.

3.2 Ethics cited explicitly and implicitly

Ethics was explicitly cited in all documents in only 1 to 2 learning outcomes or programme outcomes, which are mentioned in 1 to 2 accreditation sections of the document. In contrast, implicitly linked words from the list of common terms used highlighted a greater presence of ethics showing a total of 56 to 92 times across documents and across all the sections on Learning outcomes and programme outcomes. However, in most of these cases, this link to engineering ethics is inferred and not obvious. A breakdown analysis of the frequency of terms according to country is shown in figure 1, showing shifts in emphasis on different aspects of engineering ethics. For example, the UK brings heavy emphasis on Safety and Risk, which is mentioned 27 times. In comparison, Ireland and France mention Profession and Professional 26 and 17 times respectively. Furthermore, none of the documents mention "global", "Values" or "Justice" and only Ireland mentions "integrity".

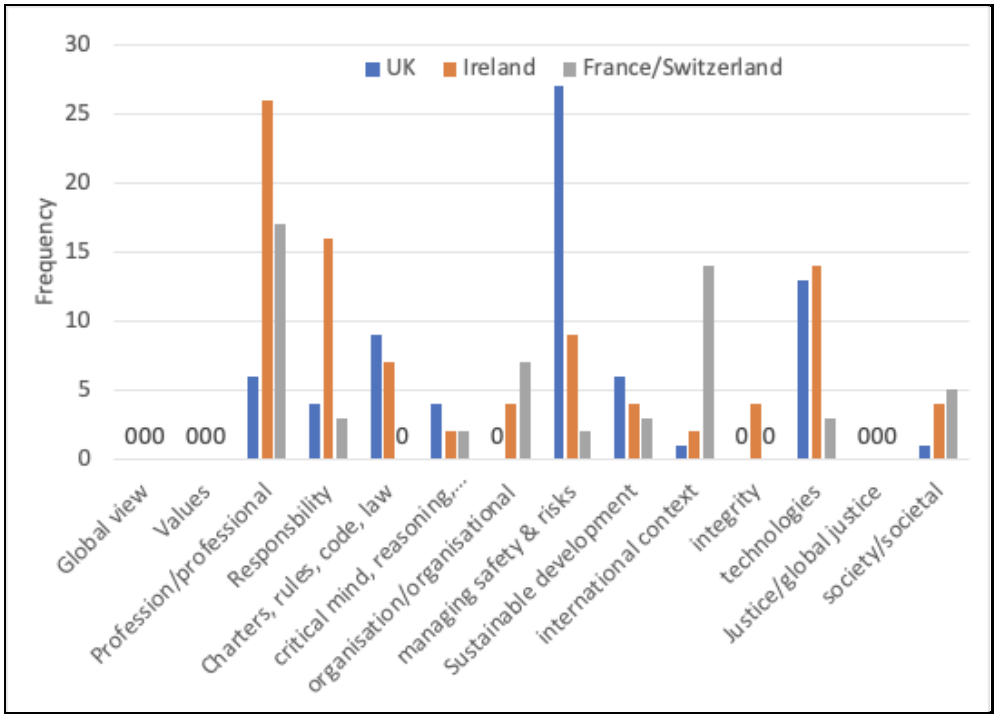

Fig. 1. Words implicitly linked to ethics found in Learning Outcomes or Programme Outcomes accreditation documents according to country

3.3 Use of verbs in learning outcomes cited on ethics

The verbs used in the accreditation documents to describe learning outcomes for ethics-related subjects were analysed and categorised according the Bloom's Taxonomy of learning, showing that most of the verbs related to the lower levels of learning, for example, "know", "define", "awareness" and "exercise" (Table 4). It was also noted the France/Switzerland documents had a wider spread of verbs such as "improve" and "design", which appeals to the higher learning levels of "evaluate" and "create". The same verbs used in the accreditation documents were also categorised into Doing actions, Thinking actions or Both (figure 2) showing a heavier emphasis on Thinking actions.

Table 4: Evaluation of verbs linking to ethics from the accreditation documents and according to Bloom's Taxonomy of learning

		Verbs used in Accreditation Documents Note: verbs colour coded according to Bloom's Taxonomy																	
		Know (knowledge)	Define	Consider (take into account)	Understand (understanding)	Awareness (aware)	Exercise (e.g. initiative)	Commit	Implement	Test	Questioning	Exploit	Identify	Evaluate	Reflect	Investigate	Self-assess	Improve	Design	Master
Accreditation body	UK: IMechE (Engineering Council)	x	x		x	x	x						x			x				
	Ireland: Engineers Ireland	x	x		x			x							x	x		x		
	France & Switzerland: CTI			x	x		x		x	x	x	x		x			x		x	x
Bloom's Taxonomy	Remember																			
	Understand																			
	Apply																			
	Analyse																			
	Evaluate																			
	Create																			

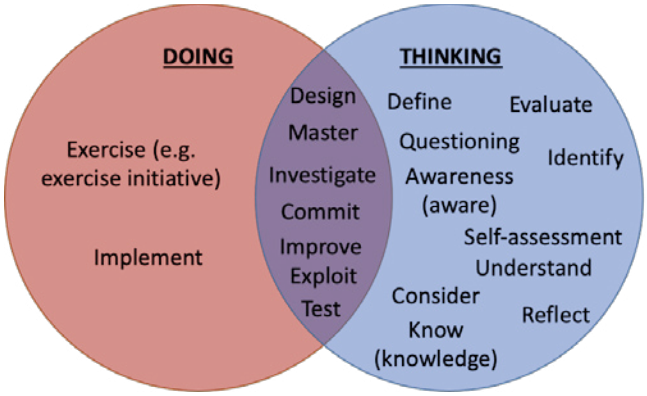

Fig. 2. Verbs from accreditation documents linking to ethics categorised according to either Doing actions, Thinking actions or both

4 DISCUSSION

The training of engineers in ethics is situated within the framework of applied ethics, participating and even guiding the decision-making process of engineers. As such, it is the field of so-called normative ethics (the study of ethical behaviour) as well as applied ethics (applying ethical theory in real life situations and decision making) that interests us here. The construction of the authors' works shows that the major challenges of such training are to enable engineers to manage the ethical implications of their work and their place in society. Three learning points were summarised from the analysis of this study.

Firstly, there is a difference in definitions across documents which will impact how these programmes and subject-specific learning outcomes are written. This might create implications in how engineering education programmes prepare their graduates for their future professions. Since the world of work has become highly globalised and international, it is important to have a stronger, and to some extent, unified understanding about ethics in engineering. Furthermore, ethics in engineering

in itself brings forward an emphasis on continuous reflection around how certain engineering actions impact the local and global contexts (environments, societies, resources, et cetera), thus having varied definitions might feel a step backwards in preparing future engineers to act and think ethically.

Secondly, all documents do include engineering ethics stated in their Learning Outcomes or Programme Outcomes but most of the verbs used are generally lower in Bloom's taxonomy and referred to more thinking verbs than doing verbs. This makes inclusion of ethics in the accreditation process seem more symbolic and open for interpretation by the higher education institutions implementing engineering programmes. If ethics is more linguistically represented as a thinking than as a doing verb, it might lead to disassociating it with practical engineering knowledge, and therefore offering a more theoretical or philosophical approach to the subject. The implications of which results in no real impact to an engineer's work.

Thirdly, there are many implicitly important ethical concepts in sections of the documents that can be open to interpretation. When the common terms (table 1) were used as a frame of reference, this wider use of terms showed all sections of the accreditation documents were subject to applied ethics. This demonstrates the presence of ethics in all sections of an engineering programme. This will mean that degree programmes will have varied levels of engagement on ethics depending on the interpretation and therefore how the programme is structured and delivered in practice. Without a clear explicit "demand" for ethics at the educational institutions, there is a danger that ethics will remain on the margin, taught by (sometimes competing) humanities and/or social science faculties/teachers, and hence perceived by students to be marginal to the core of engineering education. This will also continue to impede integration of ethics in the core curriculum by teachers of engineering disciplines and make the process of moving ethics closer to the more technical disciplinary knowledge slower.

We propose a more direct mention of ethics in all sections of the programme or set an agreed definition that encompasses the depth and breadth of the engineering topics that involves the awareness of ethics in engineering. Engineers must therefore be able to situate their actions or decisions in a societal context and the ethical issues related to it. They have to develop possible solutions and then evaluate the ethical quality of these solutions in order to arbitrate and decide. Finally, they have to develop their ability to think and decide ethically. This approach is particularly emphasised by Poel and Royakkers (2011) as major axes in engineering ethics education [10].

On reflection of the use of language, there is some frustration when verbs are taken in account with little understanding of their complements, such as: understand, reflect, consider, commit, act...on what? These verbs can be applied to every domain; however, when focusing on ethics, what is it saying and what is the intended meaning? This opens up a deeper level of linguistic analysis for further exploration.

There are several limitations to the study, firstly this analysis focuses on verbs alone. The reason for this is verbs are used as the key to understanding and therefore drives our competencies and learning outcomes as reflected in the documents analysed. Since learning is driven by this, the data in this study naturally relies on evaluating the use of verbs: what we do rather than what we are. On the other hand, what we are: our identity, emotions and how we feel does indeed drive what we do, however this is less tangible and therefore very difficult to evaluate.

Secondly the documents were analysed in the English language. The original English translated glossary of the French/Swiss document was therefore used in the analysis. However this opens an important discussion on the strong link between language and culture, context and values. This in turn influences how these are understood, expressed and applied. This would need to be explored in future to include a native language assessment as part of the analysis.

Thirdly the use of common terms such as “responsibility” are too general and therefore its role in ethics education is open to interpretation or lost in translation when transitioning from understanding to application. It is hoped that this paper has highlighted this challenge, calling for a more explicit definition of terms or terms of use. It may be that a global and wider understanding of the *definition* of ethics and related terms is needed. In light of the earlier point on the impact of language, there is also a question of whether this is possible.

Finally, the use of textbooks in generating the terms are already outdated in current and future challenges our societies face. However these textbooks are in current use and commonly feature as reference text in engineering programmes. This does raise the need for a renewal of some of these books as reference text that brings more emphasis to our future challenges as a global community.

5 SUMMARY AND ACKNOWLEDGEMENTS

The aim of this paper was to take a top-down approach and carry out a word analysis on how engineering ethics is taken into account in national accreditation documentations in Europe. Although ethics is given some importance, its study and application were shown not to be directly linked to a broader treatment of ethical, social and global aspects in engineering. The authors suggest a common global working definition should be established that encompasses the broad spectrum of ethics and its application in engineering programmes. Through this top-down approach it is possible to bring a more comprehensive incorporation of ethics, taking its practice from the periphery to the heart of accreditation requirements, and therefore in engineering programmes.

The author list has been arranged in alphabetical order to reflect the equal contribution to the study design, data collection and analysis.

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