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Addressing graduate competencies: Understanding the contextual factors impacting the engineering discipline

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Abstract

The knowledge of contextual factors that impact the engineering discipline is one of sixteen competencies that must be demonstrated by engineering graduates upon completion of an accredited engineering degree in Australia. This research critically analyses learning outcomes, learning activities and assessment tasks associated with the knowledge of contextual factors for the Mechanical Engineering (Honours) degrees at two universities to determine how this competency is perceived and addressed within the curriculum. In the majority of cases, the learning outcomes do not address the competency and there are instances where this competency has been misunderstood and misrepresented. Various assessment tasks are used in the subjects that address this competency, including exams, tests, assignments, reports, presentations, tutorials, reflective journals and others. Universities and accreditation providers must review their processes for addressing this competency to ensure it is achieved. Further research is required to define this competency for better alignment and understanding of learning outcomes.

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Keywords: Contextual factors; learning outcomes; curriculum; accreditation.

1. Introduction

Insight into the competencies that are required of engineers can be gained from various stakeholders, including accreditation providers, educational institutions, industry, government, current and future students, graduates and

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experienced engineers. The environment in which each stakeholder operates is important, as this impacts their priorities and the value placed on certain competencies. Industry values communication skills, drive and knowledge of industry and work experience [1] and attitude [2]; established engineers place greatest value on communication skills, working in diverse teams and self-management [3]; academics value 'technical knowledge and skills', while students perceive an overlap of both attitude and technical knowledge to be important [2]. What is clear is that engineers are required to go beyond scientific knowledge and problem solving [4] and much research exists to identify the range of competencies that engineering graduates should possess [5, 6, 7].

In Australia, the Engineers Australia (EA) Stage 1 Competency Standard for the Professional Engineer [8] describes the competencies that must be demonstrated at the point of entry into the profession. This standard highlights the value placed on both the professional and personal attributes of engineers. Accreditation of engineering degrees provide assurance that the structure and content of the degree meets national and international standards of the profession for which the degree prepares its graduates. The Washington Accord, the Sydney Accord and the Dublin Accord, to which EA is signatory, also acknowledge the significant equivalence of accredited degrees across international boundaries [9] allowing graduates to work and use their skills around the world.

The accreditation process considers the 'appropriateness of educational objectives and targeted graduate capabilities, the integrity of the educational design and review processes and the means employed to deliver and monitor outcomes' [10]. The Stage 1 Competency Standard [8] used by EA during this process consists of three overarching competencies (knowledge and skill base, engineering application ability, and professional and personal attributes) which are elaborated into 16 Elements of Competency. Each element is also described using 'indicators of attainment' which provide insight into the scope of ability expected for each element. Engineers Australia does not dictate the structure, objectives or the content that needs to be covered in an engineering degree for accreditation requirements to be met. The indicators of attainment provide insight into the 'breadth and depth' of the elements of competency and are not seen as specific objectives that must all be addressed in order for the competency to be achieved. Engineers Australia tests for the attainment of each element of competency in a holistic sense and innovation and diversity in educational design and delivery are encouraged [11].

1.1 Knowledge of Contextual Factors

The need for change in the engineering education context continues to be acknowledged with the need for development of professional skills, as opposed to just the technical [12]. Accordingly, more emphasis needs to be placed on the role of an engineer. Spinks, Silburn and Birchall [13] report the importance of technical ability but also the value of 'practicality', with graduates needing a more realistic view of the world. King [14] also reports the need to engage more intensively with industry to strengthen the authenticity of engineering students' education. Consequently, this paper focuses on contextual factors of the engineering discipline as opposed to any of the other EA competencies, considering the overarching themes covered within this element of competency.

'Knowledge of contextual factors impacting the engineering discipline' formed element 1.5 (hereafter referred to as E1.5) of the 2011 Stage 1 Competency Standard for the Professional Engineer [15]. Following revision in 2013, E1.5, in its current state, also incorporates a design element: 'Knowledge of engineering design practice and contextual factors impacting the engineering discipline', forming one of the 16 competencies required of engineering graduates upon completion of an accredited engineering degree in Australia. Element 1.5 associates with the context of engineering, highlighting the need for students to understand the role and interaction of engineering and engineers within society, the importance of human factors and the context of 'real' engineering practice in terms of operating contexts and fundamentals of the workplace and the workforce. The six indicators of attainment for E1.5 include [8]:

a) Identifies and applies systematic principles of engineering design relevant to the engineering discipline.
b) Identifies and understands the interactions between engineering systems and people in the social, cultural, environmental, commercial, legal and political contexts in which they operate, including both the positive role of engineering in sustainable development and the potentially adverse impacts of engineering activity in the engineering discipline.
c) Appreciates the issues associated with international engineering practice and global operating contexts.
d) Is aware of the founding principles of human factors relevant to the engineering discipline.
e) Is aware of the fundamentals of business and enterprise management.