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Embedding Authenticity in Assessments for Engineering Education

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Abstract

Efforts have been made to adopt authentic assessments in engineering education to boost student engagement and enhance employability skills. However, comprehensive frameworks defining authentic assessment within the context of engineering – along with its objectives and implementation strategies – remain scarce. The lack of robust conceptual frameworks significantly hinders its widespread adoption by higher education institutions. Consequently, this paper identifies the key characteristics of authentic assessments in engineering education, with objectives to train learners to become reflective and globally conscious graduates who are better prepared for the ever changing modern workplaces. Additionally, it seeks to enhance student engagement and widen access to engineering education by capitalising on authentic assessments. An overarching conceptual framework for designing authentic assessments is proposed for engineering education by utilising the notion of authenticity in assessments. Moreover, the opportutinites provided by such design in mitigating the potential misuse of generative artificial iIntelligence in assessment submissions are explored. The framework proposed here allows higher education institutions to effectively adopt authentic assessments in order to train graduates with higher employability skills and address the existing gaps between graduate skills and workplace requirements. Furthermore, utilisation of the proposed framework in assessments helps instil reflective behaviours in students to contribute towards the creation of a fairer and more equitable society.

Keywords: *Authentic assessment; Engineering education; Student engagement; Employability; Globally conscious*

1. Introduction

Authentic assessments simulate workplace tasks [1] by allowing students to apply theory into practice [2]. These assessments have the potential to increase student engagement and employability skills, especially in vocation-driven disciplines such as engineering, where employers often find substantial skill shortages in graduates [3]. Authentic assessment has also been explored as a tool to improve academic integrity in the era of Generative Artificial Intelligence (GenAI) [1, 4] and effective integration of GenAI in authentic assessment has been investigated [5].

Attempts at conceptualising authentic assessments have been made by Archer et al. [6], while Villarroel et al [7] offered a course design blueprint. A broad perspective of authenticity in assessment has been developed by Ajjawi et al. (2023) [1] to add clarity and depth to the concept of authentic assessment. We utilise their perspective of authenticity to develop a conceptual framework on authentic assessment for engineering education. Although authentic assessments have been investigated for engineering education [5, 8], including pedagogies such as problem-based learning [9, 10] or the Conceive-Design-Implement-Operate (CDIO) initiative [11], a holistic framework that enhances the design of these assessments is lacking. Therefore, we propose such framework based on our experiences with authentic assessments and existing literature. Key characteristics of authentic assessments are identified in the context of GenAI and the integration of liberal studies in engineering to develop the framework, although it could be adapted for other disciplines.

2. Characteristics of Authentic Assessment

Based on authors' experiences in implementing authentic assessments in novel teaching and learning settings and existing literature [1, 12, 13], we focus on two broad objectives of authentic assessments in order to characterise them. These are: a) utilising assessments as a tool for learning and self-improvement, and b) improving self-awareness. Under these overarching objectives, two components

of authentic assessment are proposed here, namely, the employability component and the global consciousness component. The employability component is inline with ABET criteria [20], whereas the global consciousness component adds a new dimension to engineering education. It may be noted that these components support achieving the above two broad objectives, as discussed below.

2.1 Employability Component

Authentic assessments should act as a learning and self-improvement tool that enhance students' employability [14], providing much of the needed skills to gain graduate employment. Therefore, authentic assessments should simulate real-life engineering workplaces. Closed book exams at the end of the term could be replaced by regular assessments that mimic workplace tasks. Regular or periodic assessments could simulate workplace environment more effectively by embedding regular updates on work progress and correction of mistakes identified based on supervisor's feedback and self-reflection. Thus, students are likely to understand the workings of real-life engineering projects better by regular assessments rather than exams at the term end. Likewise, the assessment tasks should support performing real workplace tasks, hence the strong link between authentic assessment and real-world learning [6, 15] need to be explored through enhanced academia – industry partnership for course delivery. Accordingly, in addition to assessing specialised engineering knowledge like traditional assessments, authentic assessments should also support the development of transferable and professional skills needed in workplaces. These skills could include critical thinking skills, analytical skills, structured problem-solving skills, project management skills, communication skills and teamworking skills.

Employability component of authentic assessment should also support the development of professional behaviours that help excel at workplaces. These behaviours could include fostering growth mindset, accepting responsibility, attention to details, honesty, ethics, creativity, adaptability, maintaining safety and upholding the reputation of engineering profession. This is particularly crucial given the finding of Souppez [16], that revealed that the highest rated employability skills for engineering employers were 'personal and working attitude' as well as 'professional conduct', both of which were shown to be vastly underestimated by both students and academics.

2.2 Global Consciousness Component

Authenticity is deeply entangled with society and social practices [1, 7]. Engineering has very strong societal impacts and the need for engineers to engage more with the public has been advocated [8]. Given the huge role that engineering plays in tackling global challenges such as pollution and improving quality of life, authentic assessment should help students become more globally conscious. In addition to referring to understanding of global issues, we use the term "Global Consciousness" here to describe a reflective mindset that seeks to explore the individual relationship with the global and interconnected world. Globally conscious component of authentic assessment should help students explore why engineers do what they do, and therefore requires embedding of liberal studies in engineering education. This assessment component should help students reflect on the role they want to play in their career to impact society in a positive way. Frameworks such as the United Nations' Sustainable Development Goals (UNSDGs) could be effective ways to engage students with identifying their contribution to society.

This naturally leads to assessments that tackle so-called 'Wicked problems', defined as highly complex societal challenges that are near impossible to solve. These may include challenges related to climate change, sustainability, pollution, or poverty, i.e. strongly related to UNSDGs. Wicked problems are well documented in the literature [17, 18] and provide a catalyst for students to realise the impact the knowledge acquired across various modules can have on significant societal challenges. Such wicked problems, therefore, fit particularly well within the context of authentic assessment for engineering education.

3. Conceptual Framework

The conceptual framework proposed here helps design authentic assessments in engineering education by integrating both employability and global consciousness components. It also reduces the risks of students using GenAI to cheat in assessments [4 ,5, 19]. Authentic assessments, as

characterised in this work, are a learning and monitoring tool that is implemented regularly, similar to how lectures are delivered regularly in conventional pedagogy. Student improvement is thus monitored regularly via authentic assessments, with the part of the assessments being the students reflecting on their learning and improvement. This may be implemented with strategies ranging from logbooks (common practice for professional engineering) to regular self-evaluation against key skills targeted in the module and its intended learning objectives. Such an approach makes solely relying on GenAI much more difficult compared to a single text-based assessment, e.g. essay or report, at the end of the term. When regular assessments are treated as a part of continuous learning and improvement as proposed here, implementing non-conventional authentic assessments such as small group interviews and self-monitoring report may be more feasible. Utilisation of interviews, or viva voce, in authentic assessments may still not be possible for large class size of several hundred students. However, some form of self-monitoring and improvement report where students document their learning and improvement journey may be possible as an authentic assessment.

Guidelines to design authentic assessments to meet employability and global consciousness components are discussed below.

3.1 Design for Employability Component

Employability component of authentic assessments should support the development of students' knowledge, skills and behaviours required at workplaces. Conventional assessments typically evaluate the knowledge dimension through closed book exams or reports; however, authentic assessments should extend this by including skills and behavioural aspects.

Professional and transferrable skills to be included should be first identified for each authentic assessment. These could be teamworking skills, adaptability and continuous learning skills, and so on. The assessment should then be designed to support the learning of identified skills. For instance, adaptability skills may be embedded in a scenario-based assessment where students' response to a changing scenario is assessed. Likewise, authentic assessments should also support the development of professional behaviours. Every assessment should identify the behaviours to be developed and aim to embed them. For example, let us say an assessment aims to develop a habit of paying attention to details. In such instance, a case-study assessment may be designed where seemingly minor detail has huge significance and so forth.

Designing assessments in collaboration with prospective employers or relevant external organisations can greatly enhance the embedding of the employability component. This may be actioned via live industry briefs, drawing on local companies, or industry advisory board, present in engineering courses accredited by professional engineering institutions to enable their students to work towards chartered engineer (CEng) status in the UK context. Higher education institutions, therefore, typically already have established relationship they can draw on for live industry briefs in the curriculum. Additionally, CV-building assessments, with non-traditional deliverables, can have a career-defining impact. These may take the form of physical deliverables or artefacts (aligning well with the CDIO initiative), or videos showcasing the students work and self-reflection as part of a team-based project. The former offers relevant industry experience, while the latter makes for an easily sharable deliverable via social media platforms (e.g. LinkedIn).

3.2 Design for Global Consciousness Component

In order to produce globally conscious engineering graduates, liberal studies need to be embedded in engineering curriculums. Authentic assessment should have some societal element in it to help students become more socially and globally conscious. For example, students could investigate the social impact of a given engineering topic or technology in an authentic assessment. Another example is students investigating how national and international interconnectedness affects engineering solutions of a proposed global problem such as natural resources depletion. Likewise, how society affects certain engineering practices and vice versa could also be explored in an authentic assessment.

Introspection and reflection on the nature of the interaction between engineering and society are needed to meet the globally conscious component of authentic assessment. Reflective blog posts

where students introspect on their prospective career paths based on their personality, current global affairs and so forth could be an example of authentic assessment that addresses globally conscious component.

Case studies where students analyse how the same engineering problem is tackled differently by different countries and culture could be another example of helping students become more globally conscious. Likewise, exposure to other disciplines and studies of how students from different disciplines tackle the same problem differently can also enhance the global consciousness component.

Making students globally conscious is essential to ensure that future generations of engineers understand the crucial role engineering plays in addressing global challenges. Increased understanding of how technology, engineering and society interact with one another can also help engineers to contribute towards creating a fairer and more equitable society.

4. Conclusion

Authentic assessments in engineering education can reduce the gap between workplace demands and capabilities of engineering graduates in addition to making them more globally conscious. A conceptual framework to help design authentic assessments is developed here by identifying some key characteristics of authentic assessment. Our experiences of delivering authentic assessments are that they also help improve student motivation and engagement, although further research is needed. The framework proposed here is largely inspired by the authors' experiences of implementing authentic assessments in novel teaching settings. Further research based on more empirical cases can strengthen the design of authentic assessments.

This paper presents novel insights into the implementation of authentic assessments for engineering in higher education, and it is anticipated they may inform the design of future curricula in engineering and beyond, to enhance student engagement and employability. Finally, we call for engineering institutions to explore different types of authentic assessments and implement them in order to test their effectiveness. Greater utilisation of authentic assessments will also help generate robust datasets and case studies to compare authentic assessments with conventional assessments in future research.

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