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EDITORIAL

Educating engineers 2030 – PBL, social progress and sustainability

Engineering education faces challenges with how to respond to the integration of the Sustainable Development Goals (SDGs), emerging technologies, employability and lifelong learning. In this special issue, we focus on the future of engineering education and how problem and project-based learning could be part of the answers. We wanted to identify emerging trends for how the engineering curriculum could be formed in the future and in the call for papers we asked questions such as 'How are higher education institutions educating engineers for 2030?' and 'What type of curriculum, learning goals and qualification profile are needed to educate engineers for 2030?'.

With all the challenges lining up, engineering education in 2030 will require a student-centred and flexible curriculum, personalised learning environments and transformation of learning experiences into students' competences. Problem-based and project-organised learning (PBL) are commonly regarded as examples of the future curriculum, embracing elements such as problem orientation, communication, teamwork, interdisciplinarity, participant-directed learning, critical thinking and creativity. PBL is centred on students' learning, providing experiences and ownership over the learning process by analysing and solving real and authentic problems. Therefore, the PBL pedagogy can encompass a contextual understanding of engineering knowledge and the design processes needed to equip the students with the skills for 2030. Furthermore, this combination of contextual problems and engineering knowledge forms a platform for integrating the SDGs into education and opens up for a landscape of possibilities in developing and applying the engineering competencies needed for future professional practice (see for example National Academy of Engineering 2004, 2005; Kolmos, De Graaff, and Du 2009; Guerra 2017; Guerra et al. 2017; Guerra and Holgaard 2019; Hadgraft and Kolmos 2020).

'PBL, social progress and sustainability' is the theme of this special issue, composed of four articles. These four articles represent an emerging trend where educational change is taking place at the system level and focusing on systemic PBL curriculum, students' preparedness for the labour market, curriculum reform towards PBL, collaboration with industry partners and stakeholders, integration of SDGs and developing competences. The articles present examples of how to educate future engineers to contribute to professional and social progress as well as to sustainability.

In the first article, Bissett-Johnson & Radcliffe (2019) present a study of a project-based learning (PBL) studio course, engaging engineering students in social and sustainable design practices with external clients in developing economies. It is a review of how concepts from Socially Responsible Design (SRD), Appropriate Technology (AT) and Human-Centred Design (HCD) are integrated into a pedagogical model (Locale) focusing student effort on the socio-cultural, technical, economic and environmental aspects. The article presents empirical data from ten years of course operation, including 186 design projects, and reveals an upward trend in the socio-cultural and economic appropriateness of the solutions without any diminution of technical suitability. Furthermore, the article presents a new approach for designing and evaluating PBL courses with a focus on social and sustainable design.

In the second article, Mann et al. (2020) argue that although PBL has a history of producing strong educational results in engineering; it does not necessarily explore educational approaches to address

This article has been corrected with minor changes. These changes do not impact the academic content of the article.

the complexity of technical and social problems. Through a conceptual paper, the authors present practice-based education (PBE) as a whole-of-education approach embracing such complexity. The PBE framework comprises three main elements: (1) the context of authentic engineering practice, (2) supporting learners' agency in the process of becoming professionals, and (3) opportunities to work and learn simultaneously. The PBE framework implementation is also described in the article through a case for innovative engineering education of the Engineering Practice Academy at Swinburne University of Technology.

Mitchell et al. (2019) present a framework for reforming a traditional engineering school towards student-centred pedagogy and PBL. The conceptual design behind the framework integrates existing discipline-specific content with threads of professional skills and design through a backbone of problem-based learning experiences. One of the main goals of this student-centred pedagogy is to balance the need for an innovative education, which meets the demands of graduates and their employers, with the constraints and momentum of their existing curriculum.

The last article, by Kolmos, Holgaard and Clausen (2020), reports on a longitudinal study and students' preparedness for the labour market when educated in a systemic PBL university. The authors provide a conceptual understanding of systemic PBL in four elements – knowledge and problem modes, variation in problem and project approaches, an interlinked full-scale curriculum and focus on PBL competences and employability skills. They present a longitudinal study following a cohort of Danish engineering education students, from the first-year programme until graduation and into their first job. It shows that students from a systemic PBL university have a higher level of preparedness in terms of generic and contextual competencies, while they report being less prepared concerning more domain-specific competencies related to natural sciences.

The four articles in this special issue are examples of how engineering education responds to societal challenges. It is remarkable that two of the contributions present new conceptual frameworks for engineering curricula. These new curriculum models are institutional responses to professional and social-environmental challenges. No doubt, these examples contribute to innovation in engineering education as they also suggest variation in practices and increasing complexity of problems.

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