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Action competence in PBL: Revitalizing educational ideals to foster meaning and engagement in engineering education for sustainable development

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Summary

This abstract looks at the concept of Action Competence and its potential contribution to engineering education for sustainable development. The abstract outlines an often-highlighted issue of the missing ‘meaningfulness’ in engineering education and suggests action competence as an educational approach that can help bridge the gap between ‘meaning’ and intended learning outcomes in formal curricula. Action competence as a theoretical concept is rooted in the central European “Bildung” tradition and Danish critical pedagogy. In this abstract we take a deeper look at its origin and how it can be combined with problem-based learning (PBL) in engineering education to create a more meaningful and engaging curriculum to support a much needed transformation of the understanding of the role of engineering itself in society as well as a shift towards student-centered learning in engineering education by providing students the ability and the belief that they can be a part of solving current and future global sustainability challenges.

Keywords: Action competence, sustainable development, problem-based learning, engineering education, Bildung

Type of contribution: Research extended abstract.

1 Introduction

According to UNESCO (2021) “Engineering plays a vital role in addressing basic human needs by improving our quality of life and creating opportunities for sustainable growth on a local, national, regional and global level.” (p. 4). Furthermore UNESCO (2021) underlines the need for transformations of engineering itself, to be more innovative, inclusive, cooperative, and responsible, if the United Nations Sustainable Development Goals (SDGs) is to be reached. According to UNESCO (2021) a shift is needed from an academic technical knowledge-focused path to a much broader interdisciplinary approach to learning, and from a teacher-centric focus to one that is more student-centered and problem-based. Though the shift is already happening according to Hadgraft & Kolmos (2020) over the last 30 years there has been seen new student-centred learning methods, such as design-based learning, inquiry-based learning, problem- and project-based learning etc. Hadgraft & Kolmos states that “Problem- and project-based learning (PBL) are commonly proposed solutions in engineering education as a response to a requirement for more complex (and complicated) learning.” (p. 10). Despite this shift Hadgraft & Kolmos (2020) still request engineering education with more focus on social responsibility and sustainable development.

In this abstract, we argue for Action Competence as an educational approach to transform problem-based learning (PBL) engineering education. To broaden the perspective and potential in PBL engineering education, to include more action-oriented curriculum. Action Competence naturally relates to concepts

such as agency, empowerment, literacy and self-efficacy, however for the purpose of this paper we focus primarily on the Danish understanding of action competence as introduced by Schnack (1993) and its potential contribution to problem-based learning in engineering education for sustainable development.

We suggest action competence as a practical educational approach between scientific and technological knowledge and a radical version of the notion of “Bildung” in action competence, to create more engaging and meaningful engineering education. When we use the word “meaning” we do not only see it in terms of creating student engagement. What we see as meaningful is having students experience self-confidence in their knowledge and skills. An interplay where the students can use their knowledge of scientific content and engineering competencies to impact the greater context of society in practical and action-oriented ways.

To further elaborate on the contribution of a focus on action competence in engineering education, we will look at the two-part dimension of action competence, the pedagogical concept and competence. We will first explore the concept of action competence from a general perspective and why it is relevant to creating functional members of society. We will elaborate on action competence as a pedagogical concept, in order to outline the pedagogy behind action competence. Afterwards, we will look at the potential of action competence in its interplay with engineering education from a theoretical perspective. We will look at what it can provide engineering students, and how it has potential to broaden the perspective on engineering education. Although outlining a comprehensive guide for implementing action competence in engineering education is considered out of scope for this paper, we will conclude with a few concepts that we believe could aid in the building of engineering action competence.

2 Action competence as a pedagogical concept

Action competence is a predominantly Danish concept that originated as a reaction to teaching characterized by behavior-regulating approaches and which was especially used within environmental pedagogy/environmental education and health-promoting education. The concept arose in the late 1970s in a research environment at the, then Danish teacher training college, with roots in critical pedagogy, and only became internationally used somewhat later (Mogensen & Schnack 2010; Lund, 2020). Later, in the 1980s and 1990s it became a key concept in research and curriculum development in relation to environmental- and health education, in Denmark (Mogensen & Schnack, 2010). In our research we have noted that action competence seems to have been given new life, with an increase in published articles since 2010, which could correlate with a renewed focus on sustainable education (Chen & Liu, 2020).

Historically, Schnack (1993) is generally credited the original definition of action competence (Sass, 2020; Chen & Liu, 2020). Schnack (1993) introduced the concept in the field of political education and defined action competence in terms of the ability and willingness to be a competent participant and describes how “Education for democracy is thus education for qualification for the role as a participant. It is in this light that the concept of competence to act must be seen” (translated from Schnack, 1993 p. 7). Thus, action competence is closely linked to democratic and political personal transformation in the role as an active participant in the democratic society and to a radical version of the notion of “Bildung” (Mogensen & Schnack, 2010). In this context, “Bildung” should be viewed as more than formation of the personality through education. In the utopian dimension of critical theory, “Bildung” aims for the fulfilment of humanity: “full development of the capacities and powers of each human individual to question preconceived opinions, prejudices, and 'given facts', and intended participation in the shaping of one's own and joint living conditions.” (Mogensen & Schnack, 2010, p. 61). In this sense, “action competence” should be viewed as an educational ideal.

The concept of action as a pedagogical concept, however, traces back to Dewey (1997), who according to Lund (2020) with his pragmatic concept of experience, connect action closely with intentionality and understanding of a situation, in which understanding, and creation of meaning are both a driving force and

motivation for action (Lund, 2020). Dewey links this to problem identification, analysis, and action together with educational thinking, which emphasizes promoting action on an informed and informed foundation (Lund, 2020). Furthermore, the roots of action competence in critical pedagogy have roots in Klafki's (2007) educational ideal, i.e., in the form of "co-determination", which implies being able to take responsibility and empowered to assess and make informed decisions. Klafki (2007) places particular emphasis on "self-determination", "co-determination" and "solidarity" as rooted concepts in connection with "Bildung". According to Klafki (2007), this concept of education is characterized by the ability to act based on working through epoch-making key problems, by asserting one's opinion and arguing for one's own, justified beliefs. In other words, students must be able to deal with global and current societal challenges and problems, with an emphasis on developing empowerment. As an extension, this paper takes inspiration from Biesta's (2015) understanding of education, which emphasizes inviting students to co-develop their world. Thus, the internal formation takes place in the relationship between society and the students' individual formation processes as a person, which in turn contributes to the development of society (Biesta, 2015). We therefore see that action competence as an educational approach can function as a direct invitation for students to influence, co-develop and transform their world, rather than merely adapting to the existing society.

We see the revitalization of the action competence concept in the modern education system, and in engineering education, as having roots in critical pedagogy similar to the skepticism that arose in the 1970s (Schnack, 1993) towards the view of the educational task as a matter of behavior modification, not too different from current 'leaky pipeline' discourse and instrumentalization of particularly STEM education. Rather, we see action competence as an educational approach bound in the pedagogy concept, to foster empowerment in the future of education for social responsibility and sustainable development. For students to experience a connection and relevance between the activities and their future careers and personal goals, as well as an opportunity to participate as active democratic citizens in the development of a sustainable society, it is essential that engineering education move beyond a mere focus on employability and a strong disciplinary curriculum (Mulder, 2017). Mulder (2017) argues for the need of rethinking engineering education to include, developing strategic and analytic capabilities to contribute to sustainable development and to support engineering students' public engagement during their studies (Mulder, 2017). He suggests this should have a leading role in the engineering curriculum design, including systems analysis, technology history and future studies as a foundation for developing what he refers to as techno-strategic competences, elaborating that the "(...)issue is not replacing science, modelling- and design courses; it is enabling students to connect science, modelling- and design work to the main challenges of society" (Mulder 2017, p. 1110).

2.1 Action competence as an engineering sub-competence

In the 1990s the industry voiced a concern regarding a larger focus on engineering science compared to engineering practice in engineering higher education (Edström & Kolmos, 2014). This led to an attempt at MIT with the introduction of CDIO (Conceive-Design-Implement-operate), to reform engineering education with an increased focus on what technical and scientific knowledge, skills and competencies were needed in the engineering industry.

However, the shift in focus on learning outcomes defined by the needs of the industry has not necessarily led to the desired outcome, as research shows how students still do not possess the needed competencies for real-world work situations (Walther & Radcliffe, 2007; Chen, Kolmos & Du, 2021; Hadgraft & Kolmos, 2020). Furthermore, they experience a dichotomy between their idea of the society-changing capability of engineering and the functional attribute focused engineering education (Walther & Radcliffe, 2007). This dichotomy could be perceived as a failure of engineering education to create meaning for the individual students.

Problem-based learning (PBL) has been argued to support students to take ownership of the learning process by having the students working with open ended, ill-structured and real-life problems through self-directed

learning (Edström & Kolmos, 2014). The PBL approach has a wide variation of implementations within engineering, with problems and projects varying in length and complexity, projects and cases can be picked to elicit specific learning outcomes or real-world cases that mirror the complexities and open-endedness of actual engineering tasks (Chen et al., 2021; Kolmos et al., 2020). In this way, PBL in engineering education has the potential to let students lead, driven by an inner motivation and a desire to act. However, with such a wide variation in implementations, shared strategies and common approaches are needed to ensure and encourage this motivation and ownership, particularly for new engineering students new to PBL, who might experience problems with identifying problems and effective solutions (Chen et al., 2021).

We propose that this issue could be alleviated by developing students' action competence and by having students engage with problems in society that can be solved with engineered artefacts. A review of empirical studies on action competences by Chen & Liu (2020), show how “action-oriented and transformative pedagogy cultivate students to be active participants, empower their capability of deliberating the causes and effects, and construct their visions for finding strategies toward the problems” (Chen & Liu, 2020 p. 1). This review (Chen & Liu, 2020), although not focused on engineering students specifically, highlights the potential for increasing engineering students' interest, motivation, and their perception of ‘meaningfulness’ in learning activities, by including action competence as an educational approach. We view this Active participation in society as a possible path to creating more socially responsible students/engineers as requested by Hadgraft & Kolmos (2020). Another request from Hadgraft & Kolmos (2020) is to increase integration of social contexts, here we also see the potential of action competence, as it could lead students to not only work with social contexts because it is required, but because they have a drive to help alleviate societal problems. Further we consider it important to scaffold an educational environment that allows the students to act based on their ideas and take action in the local community. Where the students can develop the self-confidence to believe in their own abilities to be able to develop new ideas and solutions to society's major problems.

In terms of implementing engineering education with a larger focus on action competence we have yet to conduct a comprehensive literature review. But we have noted the ENACT model, that uses the concept of SSI's (Socio Scientific Issues) to identify problems and through that lens has a focus on ethics, society and sustainability (Hwang et al., 2023). Although Hwang et al. (2023) does not mention action competence, it shares many perspectives with our belief of a potential direction for future engineering education.

3 Concluding remarks and future work

In this paper, we argue that the revitalization of Schnack's (1993) definition on action competence as an educational approach, has the possibility of transforming engineering education in both pre-college engineering and in higher education. A focus on action competence enforces a shift from an academic technical and knowledge-focused path to a much broader interdisciplinary approach to learning, and from a teacher-centric focus to one that is more student-centered and problem-based. We therefore see that action competence as an educational approach can function as a direct invitation for students to take action and influence, co-develop and transform their world, rather than just adapt to the existing world. In future studies, we will explore strategies for implementing action competence in practice in both K12, pre-college and engineering higher education transitions and its ability to provide the opportunity for students to experience meaning and a connection and relevance between intended learning outcomes and activities and their future careers and goals as well as opportunities to participate as active democratic citizens in the development of a sustainable society.

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