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Who am I? How Sustainability-Oriented Problem-Based Learning Shapes Students' Personal, Disciplinary, and Professional identity

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Abstract: This study explores how sustainability-oriented problem-based learning (PBL) impacts students' identity. Through twelve interviews with master's students from three Nordic universities, we identified changes in students' personal, disciplinary, and professional identities. Our analysis revealed that these identities were impacted in four ways: reinforcing, deepening, broadening or reorienting. Deepening and broadening were the most common, suggesting PBL's potential in fostering greater self-awareness and a more profound understanding of students' roles and engagement with societal challenges.

Introduction and rationale

The imperative to prepare engineers to solve complex societal challenges has reinforced research interest in active learning pedagogies, particularly problem-based learning (PBL) (Guerra, 2017). PBL is situated in contexts resembling professional practice where students address real-world problems in teams (Kolmos & De Graaff, 2014). Beyond developing students' professional competencies, PBL has potential to transform students' identity (Feng et al., 2024.; Servant-Miklos & Noordzij, 2021) – the on-going self-concept and social roles they associate with themselves (Wenger, 1998). As identity shapes an individual's interests, decision-making, and social and professional engagements (Alfrey et al., 2023; Illeris, 2014), examining identities helps understanding how PBL shapes students' commitment and engagement with societal challenges.

Sustainability education emphasizes transformative learning by combining cognitive, behavioral, and emotional dimensions to prepare students for wicked challenges (Michel et al., 2020; Sipos et al., 2008). One manifestation of this is sustainability-oriented PBL, which contextualizes learning in sustainability themes and integrates disciplinary, interdisciplinary, and ethical and societal perspectives, thereby enabling students to reflect on their potential roles in society (Guerra & Holgaard, 2019). While such experiences are suggested to facilitate identity transformation, it does not automatically translate to transformed behaviors as students may struggle to reconcile conflicting aspects of their identity (Servant-Miklos & Noordzij, 2021).

Studies exploring the intersection between PBL, identity, and sustainability education remain limited (Servant-Miklos, 2021; Sundman et al., n.d.). Yet, identity has important implications for sustainability education outcomes and transformative learning processes (Rodríguez Aboytes & Barth, 2020): it shapes how students make sense of their learning experiences and translate them into action (Brown & Bimrose, 2017; Flum & Kaplan, 2012). Further, understanding the identity development process in this context offers insights into how PBL fosters agency for sustainability, strengthens disciplinary belonging, and broadens engineering identity beyond technical aspects (Guerra et al., 2022; Trevelyan, 2010). To bridge this gap in the literature, our study explores how sustainability-oriented PBL impacts students' identity in engineering education.

Methods and data

We conducted semi-structured interviews to study students' identity development in four master's level, sustainability-oriented, PBL initiatives in three Nordic universities (A-C). The initiatives included an interdisciplinary course on global development themes (A), a university-wide program focused on societal challenges in engineering fields (B), and two monodisciplinary courses in energy engineering (C) - one within energy systems and electrical engineering and the other in sustainable energy planning. Thirty-one students participated, of which twelve (three from each initiative) were randomly chosen. The interviews included questions such as "What were the most meaningful learnings for you?" and "Did you learn something about yourself?". Our analysis was guided by reflexive thematic analysis (Braun & Clarke, 2021). All categories and themes emerged inductively.

Preliminary findings

Across the twelve interviews, students described 57 instances where they experienced their learning experience influenced their identity (Table 1). Three identity dimensions emerged: personal, disciplinary, and professional. Further analysis revealed four categories of change, which we grouped into two overarching themes: consolidating identity (reinforcing, deepening) and expanding identity (broadening, reorienting). *Consolidating* strengthened students' existing self-concept, either by reinforcing prior beliefs (n=3) or deepening their self-understanding (n=19). In contrast, *expanding* introduced new perspectives (broadening, n=23) or shifted students' focus within an existing identity (reorienting, n=12) - both leading to a more developed or redefined sense of self.

Table 1

Types of Experienced Changes across Students' Personal, Disciplinary, and Professional Identities.

	Theme	Category	Dimension of identity		
			Personal (24)	Disciplinary (20)	Professional (13)
Type of change	Consolidating identities	Reinforcing: validating or affirming existing perspectives (3)	0	2	1
		Deepening: gaining a more profound understanding of existing beliefs (19)	8	10	1
	Expanding identities	Broadening: gaining new values, beliefs, and perspectives (23)	11	5	7
		Reorienting: shifting direction or focus within existing identity (12)	5	3	4

Personal identity changes (n=24) reflected shifts in students' personal values, beliefs, self-awareness, and self-confidence. The most prominent change was broadening (n=11), where students developed new perspectives, particularly related to gaining confidence and expanding interests. For instance, one student developed openness towards working with peers from diverse backgrounds, while another developed a preference for teamwork. Deepening was also frequently described as a change in personal identity (n=8) and involved greater self-awareness, such as recognizing own leadership abilities and personal boundaries in challenging situations. Changes in *disciplinary identity* (n=20) reflected how students found meaning in their discipline and related to its values and methodologies. Here, the most common change/effect was deepening (n=10), where students described forming a stronger connection to their field. For example, one student noted they had become "more aware of my position in producing knowledge in this field." *Professional identity* (n=15) relates to how students envision their future careers and contributions to society. In this dimension, broadening (n=7) was most common, as students described discovering new career paths or becoming aware of their professional impact.

Discussion and next steps

Our findings support the notion that identity is continually shaped by the interplay between the core self and layers influenced by external factors (Gee, 2000; Illeris, 2014). In PBL, these factors are related to students' disciplines and future professions. The changes manifested in two primary ways: *consolidating*, where students' perceptions of their identities were reinforced or deepened, and *expanding*, where students' identities were broadened or reoriented. Reinforcing was the least common type of change while deepening and broadening were most prominent, which suggests that PBL facilitates discovery of new aspects of oneself and supports personal growth. This kind of self-awareness is central to transformative learning, which can empower individuals to take informed action on complex societal challenges (Jaakkola et al., 2022). To validate these preliminary findings, we will analyze the remaining interviews using the identified categories as a starting point.

The implications of our study are three-fold. First, insights into how students' identities shift in PBL contexts can help educators design learning environments that intentionally foster self-awareness, clarify professional roles, and strengthen students' sense of purpose in relation to sustainability challenges. Second, since identity shifts may evoke discomfort or confusion (Feng et al., 2024; Mälkki, 2019), our study zooms into the emergence of those shifts, which can help educators develop targeted support mechanisms to support constructive navigation of personal development. Finally, given that identity shifts are at the core of transformative learning (Illeris, 2014), our study advances the theory by contextualizing it in sustainability education – a fast-developing area in engineering education research. Beyond transformative learning, the future-oriented nature of students' identity descriptions may also suggest new theoretical avenues in this context, such as the role of *possible selves* in shaping identity trajectories (Oyserman & James, 2011).

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