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Engineering instructors' professional agency development and identity renegotiation through engaging in pedagogical change towards PBL

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ABSTRACT

This qualitative longitudinal study explored three engineering instructors' professional agency in implementing project-based learning (PBL), including multiple sets of data (18 interviews, observations, and written reflections spanning three semesters). The results show that the instructors' care for students, interest in pedagogical innovation, and efforts in professional learning supported their confidence in stance, sense of agency, and competence in PBL practice. The efficacy and strong beliefs of the instructors further supported their agency-in-action regarding how they acted to influence their teaching by negotiating both its content and conditions. The study also revealed how individual resources and social conditions frame the enactment of professional agency and how the instructors developed agency and strategies to overcome challenging issues at work. Although they developed different types of agency, they demonstrated the same attitude towards resilience and negotiation for autonomy as well as the same engagement in self-empowerment and transforming their agentic competence into educational leadership.

1. Introduction

Against the backdrop of educational change and innovation, teachers are expected to develop new professional practices, whilst their professional identities are constantly being redefined and reshaped, and this has an impact on their professional lives (Edwards 2015; Fullan 2014). Teachers are agented professionals, and agency is necessary for the practice of negotiating their professional identity (Toom, Pyhältö, and Rust 2015). The professional agency of teachers, often called teacher agency, refers to their power to act, make choices and decisions, influence their work, and take stances (Vähäsantanen 2015). Teacher agency is critical in the context of educational innovation and reform because it not only affects what, how, when, where, and for how long a teacher may use various practices in the classroom, thereby shaping practices of implementation, but also promotes student engagement and impacts student learning outcomes (Cooper Stein, Kintz, and Miness 2016). In addition, teacher agency plays a crucial role in negotiating and reformatting professional identity (Edwards 2015) while also influencing teacher job satisfaction and well-being (Vähäsantanen 2015; Zee and Koomen 2016).

While the role of teacher agency has recently received growing attention, the research is still in the early stages of definition and conceptualisation in the context of higher education (Godwin et al. 2016). While the traditional roles of university instructors, namely research, teaching, and service, are growing increasingly complex in the on-going process of global educational change, instructors today are also responsible for providing students with professional practices involving multiple concepts, such as problem-solving, critical thinking, reflective thinking, and collaboration. Indeed, these competences are considered vital to the sustainable development of higher education (Thomas 2009; Van Lankveld et al. 2017). To meet these demands, it is necessary to explore the ways in which university instructors are agented professionals in developing their abilities to change and transform (Cranton 2011).

Within engineering education in particular, pedagogy is changing in response to the global challenge of preparing engineering students to handle increasingly complex and complicated problems, communicate and collaborate in teamwork, cope with the uncertainty and unpredictability of engineering professions, and enhance sustainability (Shephard 2015; Thomas 2009). In this process, engineering instructors' professional identities are challenged by multi-dimensional demands related to staying up to date on professional practices in engineering, conducting academic research, and engaging in pedagogical innovation (Mitchell and Rogers 2019). While recent research provides insights into the professional agency and identity development of engineering students (Godwin et al. 2016; Morelock 2017), little is known about how their instructors proact or react to the on-going pedagogical changes and renegotiate their professional identity as engineers, researchers, and educators.

This study aims to explore the individual professional agency of university instructors in the context of implementing problem and project-based learning (PBL) in engineering education from a longitudinal perspective. Taking a subject-centred, socio-cultural approach to agency (Eteläpelto et al. 2013) as its point of departure, this study proposes a conceptual framework for the development of university instructors' agency in the context of pedagogical change. This framework guided the study in gaining an understanding of three engineering instructors' experiences of implementing PBL at two engineering colleges in Qatar and China.

2. Conceptual framework

2.1. Understanding teacher agency

The understanding of agency varies by discipline. From a social-cognitive perspective, Bandura (2006) has highlighted four core properties of human agency that individuals attain: (1) intentionality, which includes actions and strategies; (2) forethought, involving goal setting and anticipating the outcomes of prospective actions to guide and motivate; (3) self-regulation, involving the deliberative ability to make choices and action plans and to construct action to regulate the execution; and (4) self-evaluation, in which one reflects upon oneself and makes improvements. Individual agency is reflected through the individual's self-efficacy, beliefs about their capacities, and competences to act and achieve (Bandura 2006).

While acknowledging individual capabilities and power to exercise agentic choices and actions, Archer and Archer (2000) situated agency within individuals and their social circumstances and conditions, and argued for the inseparability of the social and the individual aspects and the role of context in limiting or supporting an individual professional's agentic action. Also highlighted by Archer was the temporal nature of professional agency through addressing the mutually constitutive interaction. In line with this view, recent research on professional agency tends to search for a pathway between individual accounts of cognition and how they are confined by social factors (Billett 2006). Agency has recently been conceptualised as being achieved by individuals through the interplay of personal capacities and the resources and constraints of the social context (Eteläpelto et al. 2013). In this way, teacher identity and agency should be seen as dynamic and influenced

by the social and cultural contexts in which they are situated, rather than being fixed in a vacuum (Billett 2006). Particularly, teacher agency manifests personal, relational, and situational and contextual resources for agency (Jääskelä, Häkkinen, and Rasku-Puttonen 2017).

Emphasising the subjective and individual developmental perspective, Eteläpelto et al. (2013) proposed a subject-centred socio-cultural approach to agency in which professional agency is 'practiced when professional subjects and/or communities exert influence, make choices and take stances in ways that affect their work and/or their professional identities' (61). Embracing the underlying individual cognition and the indispensable role of social contexts, this approach provides opportunities to understand agency at the personal, relational, and environmental levels. At the personal level, it addresses an individual's prior experiences, motivation, interest, intentions, beliefs, efficacy, subjectivity, and identity (Billett 2006). At the relational level, it examines participation and collaboration, peer communication, and conflict resolution. At the environmental level, it facilitates understanding of how institutional policies and supports that may impact the practice of agency at work. Taking its conceptual departure from this approach to understanding professional agency, this study emphasises the interplay between the individual development of agency, subjectivity, and identity and the socio-cultural context, and highlights the intertwining of individual professional identity and practices with individual choices about action and engagement (Hökkä, Vähäsantanen, and Mahlakaarto 2017).

2.2. Framing university instructors' professional agency in the context of pedagogical change

Discussion of agency in educational contexts remains new and scarce (Jääskelä, Häkkinen, and Rasku-Puttonen 2017). In particular, the current literature on university instructors is mainly focused on their academic path in general (O'Meara 2015). Facing requests for pedagogical change in their daily practice in addition to pressure to develop academically and be promoted within the university, many instructors experience reduced self-efficacy and motivation, competitive relationships with colleagues, and confusion about their professional identity (Van Lankveld et al. 2017). Therefore, there is a need to understand and explore how university instructors develop professional agency to navigate their academic career in the context of pedagogical change.

Embedded in the subject-centred socio-cultural approach to agency (Eteläpelto et al. 2013) and inspired by Cowan's (2006) reflection model for university instructors, this study proposes a conceptual framework to explore the understanding of university instructors' professional agency development in the context of pedagogical change. This framework views agency as a socially constructed phenomenon that is closely intertwined with individual subjectivities and identities through practices and negotiation in the given context. The thematisation of agency should emphasise its temporal nature, including its continuity with the past (influences of prior experiences), the present, and the future (desired goals) (Archer 2000). In particular, following Cowan's (2006) reflection model, including prior experience, reflection-for-learning, exploration, reflection-in-action, consolidation, and reflection-on-action, the proposed framework includes three stages through which these teachers develop agency during a pedagogical change process. These stages are agency-for-action (prior experiences and preparation for change); agency-in-action (implementation of change, including exploration and consolidation); and agency on prospects and future orientations.

Agency-for-action: drivers and readiness for change
Agency is a temporally embedded process of social engagement that is performed in the present but informed by the past (Eteläpelto et al. 2013). Therefore, understanding and reflecting on prior experiences may be the first agented action that provides a good basis for motivation and preparation for the designated change (Du, Chaaban, and ALMabrd 2019; Du and Chaaban 2020). A teacher's agency in preparing for change plays an important role in defining how they take action towards implementing change (Fullan 2014), which includes visions and intentional goals (Bandura 2006) and a

sense of purpose that incorporates motivation, attitude, and stance as well as an understanding of the prospective change (Pantić 2015). In particular, an individual's beliefs in their own efficacy are seen as the core mechanism influencing their actions, sense of agency, stance, and confidence in their ability to reach the targeted goals (Bandura 2006; Biesta, Priestley, and Robinson 2015). Building efficacy not only has a positive impact on a teacher's relevant skills and competences for change (Pantić 2015) and on their well-being, but also helps students to improve their academic achievement (Zee and Koomen 2016).

Agency-in-action: engagement, regulation, reflection, and evaluation in implementation

In the process of implementing change, teachers must develop several different aspects of agency-in-action (Wilcox and Lawson 2018, 186). First, from the perspective of self-regulation theory, the ways in which they establish plans in line with their goals constitute an important step to being committed to a particular change (Bandura 2006). The second aspect is the level at which they are engaged in implementing the change behaviourally (e.g. the adjustment of classroom activities and assessment methods), cognitively (e.g. developing pedagogical knowledge, teacher learning, problem-solving, and decision-making), and affectively (e.g. handling pressures, relationships, and conflicting issues) (Wilcox and Lawson 2018). The third aspect involves making decisions concerning justification and adjustment during implementation in order to adapt the implementation to student needs and the given conditions (Du, Chaaban, and ALMabrd 2019).

The ability to self-reflect and evaluate is highly valuable not only from a social-cognitive perspective (Bandura 2006) but also from the socio-cultural point of view on transformative learning (Cranton 2011; Pantić 2015). For university instructors, it is crucial to engage in critical reflection by questioning the taken-for-granted norms and seeking alternative solutions to teaching, learning, and educational issues (Kreber 2006). It is also essential that teachers are able to evaluate whether and when they will reach the goals they set for themselves (Edwards 2015; Pantić 2015).

Agency on prospects and future orientations

From a lifelong learning perspective, agency should be linked not only to an individual's short-term goals and actions, but also to their long-term life objectives and plans (Emirbayer and Mische 1998; Eteläpelto et al. 2013). Critical reflection on engaging with pedagogical change may benefit one's role as a university instructor in the long run, and in particular, questioning the overall objectives of the curriculum and education (in engineering) will further engage teachers in developing a sustainable commitment to transformative learning and agency development (Cranton 2011).

The notion of empowerment is embedded in the discussion of agency development in the context of educational change. Critical reflection is the key to constructing pedagogical beliefs and knowledge, which leads to transformative learning for self-empowerment (Mezirow 1991). In the process of implementing new pedagogy, university instructors demand the autonomy to make choices and take action, and while they sometimes struggle in the power game to make meaning of the institutional and cultural factors (Pantić 2015), the empowerment of the community can be enhanced through the collective development of professional agency (Freire 1970).

2.3. Developing professional agency in pedagogical change towards PBL in engineering classrooms

Through the decades, engineering curricula worldwide have experienced on-going pedagogical innovation that focuses on student-centred learning and prioritises the development of professional practices in engineering students (Kolmos and Holgaard 2019). In a substantial number of these approaches in engineering education, a problem and PBL approach has been widely implemented as an effective pedagogical tool to provide students with the skills in professional demand, including communication, collaboration, and critical and reflective thinking (Du et al. 2019; Du, Naji, et al. 2020; Hmelo-Silver 2012; Strobel and van Barneveld 2009; Thomas 2009; Du, Kolmos, et al. 2020). While a rich body of literature

has focused on student perspectives and outcomes in PBL, it has also been suggested that the experiences of engineering instructors are critical to the success of PBL implementation (Kolmos et al. 2008; Du and Chaaban 2020). In particular, engineering instructors may encounter tensions in the process of change, such as defining the scope of the problem or project within the current curriculum, the varying role of the teacher's relationship with the students in lecture-based classrooms and PBL settings (Van Barneveld and Strobel 2011), and adjusting assessment methods to fit the new goals (Sabah and Du 2018; Du et al. 2019). In a recent study, Mitchell and Rogers (2019) suggested that engineering instructors consider confidence in acquiring sufficient skills to implement PBL as the key to its successful implementation. Nevertheless, little is known about engineering instructors' experiences in implementing PBL (Shekhar and Borrego 2017) and in particular about how they develop agency to manage tensions in the process (Van Barneveld and Strobel 2011).

2.4. Contextual factors supporting or constraining agency development

Previous studies (Eteläpelto et al. 2013; Van Lankveld et al. 2017; Vähäsantanen 2015) have summarised two categories of resources that may influence agency development: internal and external. Internal resources include the teacher's prior work experiences, sense of professional competences, and professional identity in terms of views concerning the goals of education, teaching, and learning, professional roles (as a university teacher), and expectations for the future. External resources include personal relations with students, colleagues, and the environment and the institutional culture at work, including its traditions, management, administration, facilities, and content of the tasks for change. In engineering education, professional workplace practices can also be an important external resource to guide engineering instructors' choice of educational practices (Patrick et al. 2017). Both internal and external resources can either support or constrain teachers' professional agency and identity. When teachers have the opportunity and flexibility to negotiate their identities through their teaching practices, they may experience increased commitment and motivation. On the other hand, when a conflict between two resources (i.e. social demands and professional identity) restricts them from making sense of their practices, these resources can have a negative impact.

The characteristics of the interplay between individual agency and structure/culture determine that research on teacher agency must examine the cultural and structural factors as well as the relationships surrounding the teacher's work (Wilcox and Lawson 2018). While the current literature collectively believes that agency is achieved rather than being static (Edwards 2015), teacher agency is mostly addressed from the perspective of one particular period of an educational change without providing a vivid narrative of the process. This study, therefore, aims to explore how individual engineering instructors renegotiate their work identity when they are involved in PBL implementation from a developmental and life-course perspective (Vähäsantanen 2015); how they exercise their professional agency through their choices, actions, and stances; and how their agency is resourced, constrained, and managed through daily discourse and practice (Eteläpelto et al. 2013). Specifically, this study intends to answer the following research questions:

(1) How does the professional agency of engineering instructors evolve during the process of implementing a new pedagogical approach such as PBL?
(2) What factors support or constrain the development of engineering instructors' professional agency in the context of pedagogical change to PBL?

3. Methods

3.1. Research context and participants

The study took place in the context of two engineering institutions in Qatar and China, respectively. Both countries have undertaken nationwide educational reforms in order to equip university

students with twenty-first-century skills, and to reach these goals, university teachers are expected to gain new competences in order to transform their classrooms (Du et al. 2019; Du, Naji, et al. 2020). Nevertheless, teachers in both countries have historically played authoritarian roles, and knowledge-transition-focused and lecturer-centred methods still dominate (Du, Chaaban, et al. 2020). Thus, in both countries, PBL remains a new phenomenon in engineering education and has recently received attention from educators and researchers in response to education reformers' overall goals of providing prospective graduates with professional skills. In both engineering institutions included in this study, pedagogical innovation has been encouraged from the top down, instructors have not been given concrete recommendations for new pedagogical methods or clear instruction on implementation plans, and lectures remain the prevailing teaching mode. Therefore, the initial PBL implementation actions have taken a progressive approach, beginning with a more structured mode of course design to support students during a constructive transition process (Naji et al. 2020).

Three engineering instructors — UE, KN, and JP — participated in this study over three academic semesters (each lasting 4–5 months), namely Spring 2018, Autumn 2018, and Spring 2019. Prior to this study, all three instructors had volunteered to participate in different types of PBL pedagogical development activities organised by their institutions (for details, see Table 1) and facilitated by a PBL expert who is a co-author of this study. After engaging in this pedagogical development and based on their own motivation and interests, the three instructors decided to begin implementing PBL. Initial PBL implementation took place within the courses these instructors were teaching and was, therefore, at the course level. Any pedagogical approach used was first and foremost obligated to fulfil the course objectives, and the instructors added other intended learning outcomes, including problem-solving skills, project management, and teamwork. The PBL expert, who works internationally to support pedagogical development, acted as a pedagogical mentor to support the instructors' PBL design and implementation in this study. Since the three instructors aim to further develop their critical reflection through a research-based approach to pedagogical change (Kreber 2006), they are, in fact, playing dual roles as subjects and researchers of this study.

In the context of engineering education, PBL has been defined in various ways. The Aalborg PBL model (Kolmos and De Graaff 2014) provided the philosophical and conceptual foundations of the professional learning activities the three instructors attended and, therefore, also informs this study; it proposes problems, projects, and teamwork as the foundational characteristics of PBL. In particular, the design of the instructors' pedagogical development activities followed the PBL principles in engineering education suggested by Kolmos and De Graaff (2014), which include a process of problem identification and analysis, project organisation as the core of the course, lectures playing a supporting role, and team project reports as final PBL outcomes. Based on these principles, the three instructors created PBL implementation plans relating to their specific courses. Due to the constraints of the overall curriculum structure, PBL was only implemented at the course level. In the Qatari university, each course runs for 14–15 weeks (including assessment) with either two 75-

Table 1. Participant Information.

Name	Gender	Country	Years of Teaching Experience	Classroom Size	Management Experience	Discipline	PBL Professional Learning Experience
UE	Male	Qatar	Over 20	Around 30	Yes	Civil Engineering	Two 3-day pedagogical development workshops hosted at the institute with external experts.
KN	Male	Qatar	Over 20	Around 30	Yes	Civil Engineering	
JP	Female	China	Over 20	Some 120, some 30	Yes	Pharmaceutical Engineering	A 6-month PBL programme for engineering instructors hosted by Aalborg University in Denmark, where PBL has been systemically implemented for over 40 years.

minute class periods (Mondays and Wednesdays) or three 50-minute periods (Sundays, Tuesdays, and Thursdays) each week. In the Chinese university, each course runs for around 10–12 weeks, with two two-hour class periods each week.

Among the three instructors, the variations in the nature of the course, schedule, instructor's experience, and institutional factors meant that PBL was practised differently in each context. However, common procedures were undertaken for each of their first PBL courses. The instructors designed an overall project theme with a designated topic based on a real-life problem, then had each student team choose a particular aspect of that problem as the focus of their project. In this study, instructors' courses emphasised the project and teamwork elements of PBL as students formed their own teams, and team-based grades constituted a minimum of 60% of their overall final course grade. This grading strategy was part of the alternative assessment methodology designed by the instructors and guided by the principles of constructive alignment (Biggs and Tang 2011). In addition to the minimum 60% group project assessment throughout the semester (divided into a few stages of project progression), a student's grade also included up to 40% comprising different individual assessments (which were handled differently depending on the course objectives). Rubrics were provided to students to guide their projects from the start. These PBL grading systems represent a significant change from the previous systems, which were 100% based on individual written exams.

Although the overall assessment approach used by the three instructors was similar, PBL practises regarding problem identification, the division of contact hours between lectures and PBL sessions (in which students worked on their team project with the instructor's support), and the concrete division of individual and group project grades varied from course to course. Details of the arrangements across courses are provided in the section corresponding to their implementation process in the findings. Examining implementation processes is also a way to reflect on how instructors made choices and took action in response to their surroundings.

At the end of each semester, student perspectives on the PBL courses were gathered, and all three instructors worked as a research team together with the PBL mentor to evaluate diverse aspects of student learning in PBL. Some of these results have been reported in our recent publications, including our findings on students' perceptions, satisfaction, development of deep learning, and views on teamwork (Du et al. 2019) as well as students' self-directed learning strategies and team learning strategies (Du, Naji, et al. 2020). Participating in a research-based approach also demonstrates how the three instructors developed their agentic choices and actions in the process of PBL implementation.

3.2. Research design and data sources

A longitudinal qualitative study was conducted during three academic semesters (from the beginning of Spring 2018 to the end of Autumn 2019) to provide a progressive perspective on the process of developing agency in a situation of pedagogical change. Multiple qualitative data, including interviews, classroom observation, and written reflection, were generated during the instructors' PBL implementation processes to understand their state of mind, decisions, and actions through activities in practice and in the given socio-cultural contexts.

A series of semi-structured interviews was conducted with each instructor, who was interviewed using both probing questions and emerging questions during each of the three semesters to obtain explanations that were situated in the particular context (Kvale and Brinkmann 2009). Iterative questioning techniques are also employed, including the use of probes to elicit detailed data and revisiting previously provided information for double-checking or explanation. The PBL mentor also interviewed each instructor at the beginning and the end of each semester, which added six interviews with each instructor, a total of 18 interviews.

The initial interview guidelines were informed by the proposed framework on agency development and Cowan's reflection model (2006) (prior experience, reflection-for-learning, exploration,

reflection-in-action, consolidation, reflection-on-action). During the semi-structured interviews within each semester, the instructors were invited to discuss their prior experience and preparation for PBL implementation (motivation, beliefs, self-efficacy) and to share their intentions and goals in relation to PBL at the start of the semester, their plans for implementation, the expected outcomes, and the changes they planned to make based on previous experiences. At the end of each semester, they were asked to review, evaluate, and consolidate that semester's PBL implementation — the process, procedures, milestones, and outcomes — evaluating the means by which and the extent to which the goals were reached, and what they would do differently next time. They were also invited to share their thoughts about the challenges and unexpected issues they faced and how they interpreted these situations, made decisions, took action to cope with them. All interviews were conducted in English, audio-recorded, and transcribed into text for analysis. Informal talks were also conducted with questions that emerged during the semester along with the observation sessions and notes that were made from these informal talks as a way to triangulate the observation data.

Classroom observations were conducted to illuminate the meanings of instructors' actions during their teaching activities (Cohen, Manion, and Morrison 2013). These observations were conducted by the PBL mentor and were non-participant in nature. Observation methods included following the instructor, focusing on their actions in the activities and practices, and observing their intentions, interpretation, judgements, and evaluations (Edwards 2015). Regular classroom observation was conducted on a weekly basis on average for the two instructors in Qatar, with particular attention paid to how the instructors organised PBL sessions during classroom time and how they facilitated student groups. For the third instructor in China, the PBL mentor could not conduct the observation in person but took an alternative approach to following the progress of PBL implementation through regular talks and by listening to the instructor's narrative of what happened at each stage. This imbalance of observation remains an acknowledged weakness of this study. To compensate for it, however, the PBL mentor made efforts to have more frequent discussions with the participant in China in order to compensate for this imbalance in a second-hand way. Written notes were taken throughout all observation sessions.

After the third PBL course, the instructors provided written reflections in English, in which they reflected on their overall experience of PBL implementation over the three semesters. The length of their reflections varied from 6 to 10 pages. Emphasis was placed on how they self-evaluated their 1.5-year-long efforts in pedagogical change—what had changed for them and for their students, the lessons they had learned, and the further changes they anticipated.

3.3. Data analysis

The gathered data amounted to 258 pages of material, including 162 pages of transcribed interviews, 68 pages of observation and informal talk notes, and 28 pages of written reflection. Focusing on meanings and context, the analysis was conducted using an inductive and deductive approach, and the authors individually and collaboratively conducted several rounds of comparing multiple data sources (Cohen, Manion, and Morrison 2013). First, following the proposed framework, all data sources were structured based on the stages of agency-for-action, agency-in-action, and agency on prospects and future orientations. Within each stage of the framework, we then categorised each data source—interviews, observation, and written reflections – separately. Then, a thematic analysis was conducted in order to identify emerging patterns, and the identified patterns from each data source were compared and combined. Using the proposed framework as a guideline to understand the process, themes emerging from the bottom-up analysis were also identified a priori (Kvale and Brinkmann 2009). Through several rounds of categorising meanings from multiple data sources, we aligned the emerging subthemes and the themes from the framework with the coding samples shown in Table 2, following Saldaña (2015).

As illustrated in Table 2, the proposed theoretical framework provided assumptions for agency evolvement as a starting point of the inquiry. The combined deductive and inductive process

Table 2. Coding Scheme with Sample Themes and Data.

	Themes	Subthemes	Sample Data
Agency-for-action	Drivers and readiness for change	Instructors' motivation and beliefs	'I believe that PBL is the most meaningful way to solve the issues in the current teaching and learning in China.' (JP interview 1)
		Instructors' actions in preparing for PBL implementation	'Although I am not an educational expert, I did try to read literature about PBL and learn from others so that I could do PBL in a correct way.' (UE written portfolio)
Agency-in-action	Engagement, regulation, and reflection and evaluation in implementation	Evaluation from the student learning perspective	'I am quite critical of my own PBL practice; although I am enthusiastic and I benefited from PBL from my own learning in the training program in Denmark, I also wish for my students to go through the same process. So, I am always concerned about how they feel about it, whether they really learned from this, and how I can adjust to fit them.' (JP interview 3)
		Evaluation from the institutional perspective	'Piloting PBL is important, but it is more important that we document our practice through evidence of student learning, so participating in educational research is essential to convince people in our environment that PBL is useful.' (KN written reflection)
		Handling challenges	'Through piloting PBL twice, I have to say it is not easy. The institutional support is missing, despite good intentions from the college and university. It's good that I can talk to KN so that I am not totally alone in this environment.' (UE interview 4)
		Resilience	'Although there are concerns from my colleagues, and we need to be careful when doing something new in our environment, I am not worried. This is the best way to go and we will make the change slowly.' (KN interview 4)
Agency-on-prospects and future orientations	Instructors' perceptions of future steps	Prospects for instructors' individual plans	'Now I have tried PBL three times, and two were in the same courses. I have developed my skills to adjust to different student reactions and I am confident in handling more different situations. As a next step, I will consider involving industry mentors in my own PBL course.' (UE interview 6)
		Prospects for student development	'There is a lot to do in order to adapt PBL to our context. Making sense of PBL in a big classroom is still much more difficult than a classroom of 40. I need to further work on the online support system to find more strategies for PBL in a big class.' (JP written reflection)
		Prospects for institutional development	'We need a more institutionalized approach to further change to PBL, balancing the requirements of accreditation and university top management … there is still a journey to go but we will make the changes that fit the culture.' (KN interview 6)

confirmed the initial themes suggested by the framework, based on which emerging themes were identified; for example, for the theme of agency-for-action, we not only confirmed the important role of motivation, beliefs and self-efficacy, but we also found that the instructors all took actions to prepare themselves for the pedagogical change (PBL implementation) (e.g. reading literature). For the theme of agency-in-action, in addition to confirming the essential role of reflection, regulation, and self-evaluation, the study also identified emerging themes of handling changes (e.g.

compromising, changing strategies) and resilience. For agency on prospects and future orientations, in addition to the instructors' own plans, themes on prospects for student and institutional development were also developed. In this way, we confirmed that the proposed framework would be suitable for the aims of the study: it would facilitate an overall understanding of the agency and identity development process for pedagogical change while also recognising the variety of practices possible within the scope of the framework (Kvale and Brinkmann 2009).

3.4. Trustworthiness and methodological reflection

Throughout this study, the authors all played a dual role as both participants and researchers. While this dual perspective offers insight into the process of PBL implementation, it also generates insider bias, which represents the major weakness of the study. For example, it is possible that in highlighting the promising aspects of instructors' participation in pedagogical change, we may have interpreted instructors' overcoming challenges in an over-positive way and thereby downplayed their individual suffering as a result of those challenges. In addition, the facilitator, despite attempting to provide options and feedback that allowed the instructors to take action on their own, unavoidably played an influential role in the instructors' decision-making processes and actions simply by virtue of providing suggestions.

Following Guba and Lincoln (1989), we have made efforts to improve the trustworthiness of the study by iterative questioning through different rounds of interviews and by triangulating data from multiple sources and from the reflective commentary. The member check technique was also employed through frequent debriefing sessions, in which the PBL mentor discussed numerous rounds of the initial analysis of each data source with the other authors/participants (Cohen, Manion, and Morrison 2013). We also conducted individual analyses prior to collaborative discussions, which were carried out until an agreement was reached. Furthermore, each instructor made an effort to critically consider the study from both the instructor and researcher perspectives and with the goal of improving PBL practices (Kreber 2006). The PBL mentor, who is a professionally trained and experienced qualitative researcher, made reflective commentary throughout the research process, noting the initial impressions of all data collection sessions including emerging patterns that related to the proposed theoretical framework. This process of monitoring through commentary is the key to what Guba and Lincoln (1989) stress as progressive subjectivity in building trustworthiness in a qualitative inquiry.

Additionally, peer scrutiny of the research was conducted through an auditing procedure (Akerman et al. 2008), in which two external experts (who did not know each other) read through the proposed framework, coded selected data (transcripts and notes), and reviewed the results and interpretation of our analysis. Both experts are experienced researchers in qualitative approaches to educational research, although not in the field of engineering education. The first expert, familiar with the societal and higher education culture in Qatar, supported the study by discussing the proposed theoretical framework, underlining the importance of including Bandura's work on self-efficacy as an important element of agency-in-action, and interpreting the data focusing on the positive perspective to provide a premise for peer colleagues to join the change taskforce. The second expert, familiar with the societal and higher education culture in China, was invited when the research had been completed. The auditing procedures included confirming the appropriateness of the theoretical framework and providing an explanation of how institutional policies may constrain the actual implementation of PBL.

Both experts read through samples of the data in texts and individually conducted analyses using the provided coding scheme with one sample of each data source (one interview transcript, one observation note, and one written reflection). They confirmed the appropriateness of the coding scheme. Both experts expressed their understanding of the difficulty in implementing new pedagogy in an environment where lectures are the prevailing teaching method and the institutional policy tends to favour a research focus over a teaching innovation focus. They also shared the

views that in a study reporting instructors' voluntary pedagogical change, optimism is more meaningful than pessimism for encouraging change in the long term.

4. Findings

From a subject-centred socio-cultural perspective, agency should be analysed with an emphasis on the following: (1) a person's interpretations, meanings, and goals in relation to their agentic actions and (2) the intertwining of professional agency and identity in response to personal relationships, social norms, and institutional conditions (Eteläpelto et al. 2013). In this section, we report the findings of our research questions as guided by the proposed conceptual framework (agency-for-action, agency-in-action, and agency on prospects and future orientations) and in an integrated form, thus merging different sources of qualitative data.

4.1. Agency-for-Action

Motivation for change
In their own experiences as students, the three instructors were all educated in a traditional lecture-centred environment. They also shared a sense of empathy and urgency for change when observing unmotivated students in their own classrooms. They all sought alternative pedagogical methods in the hope of motivating students and providing them with the skills needed in professional practice, such as communication and collaboration. Instructors cited different motivations as the main drivers in their decision to implement PBL. While JP reported 'care for students' as her main driver in her decision to implement PBL, UE referenced his self-development goal of 'being an expert in education in addition to being an engineering professor' so that as a programme coordinator he could better develop not only his own class but also the whole programme 'in an educationally correct way.' KN wished to prepare all engineering students in the college for the current fourth industrial revolution, in both the global context and in one particularly relevant to Qatar. Although the instructors lacked prior PBL experience as learners, they were driven by their passion for student learning. Their dissatisfaction with the current situation drove them to search for alternatives.

Beliefs about PBL
This shared hope was what drove them to join a pedagogical training programme for PBL, through which, as stated in their initial interviews, they became 'true believers' in the method for their own students. In particular, JP, who significantly benefited from her participation in a six-month PBL programme in Denmark prior to implementing PBL in her own classroom, wished to invite her students in China to experience 'a journey of independent and collaborative learning in PBL.'

By participating in professional learning activities, they developed strong beliefs in PBL as a strategy to solve the issues they encountered. Driven by this belief, they reported positive attitudes and stances and had well-prepared plans.

Preparation
Prior to their decision to implement PBL, the instructors all read through the PBL literature and had each developed a PBL teaching design as part of their participation in the programme. Having decided to implement their action plans, they each worked with a pedagogical expert in PBL (the PBL mentor) to discuss the details of actual implementation. Following the principles of constructive alignment by Biggs and Tang (2011), they adjusted the learning outcomes of the course while altering the grading scheme to give more weight to student skills rather than information gained, and they modified the assessment methods and scales to be aligned with the goals of the course and PBL method. Through the preparation, they developed confidence and efficacy in making their first experience successful.

Nevertheless, prior to the first implementation, the instructors all expressed concerns regarding the unpredictability of feedback from students, colleagues, and institutional leaders. In particular, both UE and JP mentioned 'the need to make this first experience a great success.'

4.2. Agency-in-Action

The agency-in-action of the instructors is reported below, which is structured following multiple sub-themes including plans of exploration, monitoring, regulation, self-reflection and evaluation, consolidation, handling challenges, and resilience.

UE

Inspired by the PBL literature, UE started his first PBL course with a flipped model by putting all lecture content (slides, readings, notes, videos) online and organising classroom activities as team projects. In this course, he used three 50-minute class sessions each week as PBL sessions, during which he worked as a facilitator supporting each team project. The course evaluation at the end of the first semester (conducted by the PBL mentor) and his own observations both revealed that despite the support and appreciation of most students, around 10% of the class showed resistance to the dramatic change from a lecture-based method to PBL as well as a lack of understanding of PBL. In addition, more than half of the students expressed concerns regarding fairness when the entire team received the same grade.

UE changed his strategy for his second PBL course. Having observed that students favoured direct input from the instructors, UE used lectures during classroom sessions instead of the flipped model to provide basic information about theories and information relevant to student projects. Of the two weekly class sessions (75 min each), one was a lecture and the other was a PBL session focused on team projects. He reflected in writing: 'I learned that our Arabic students need more direct information so that they can feel safer. Letting them wander around to search for the basic knowledge is overly confusing for my students. Therefore, I adjusted my strategy to provide them more direct input to satisfy their needs.' In order to enhance both individual student learning outcomes and teamwork outcomes, he also adjusted the assessment to increase the project grades from 50% to 70% and adopted an alternative way of assessing individual learning, asking each student to report on their team project through a five-minute self-recorded video. This second semester turned out to be highly satisfactory for his students, with no resistance reported in the evaluation. He was also satisfied with this approach as he believed it helped him use PBL in a manner more fitting to the local culture.

Nevertheless, during the second semester he experienced demotivating criticism from colleagues in the department who held different pedagogical opinions. These colleagues expressed concern that the reduced lecture time would deprive students of course content. Students' concerns about grade fairness were also used as an argument against PBL, since in this environment, many educators deeply believe that summative assessment is an objective way to assess student learning, while assessment via team project and report is too subjective. UE expressed his general frustration this way:

> [M]anagerial leaders and colleagues from the college and department were invited to observe my class because I decided to be open about how I do things differently, but the department colleagues did not fully believe that students may learn through doing team discussions in class. I could not totally ignore their concerns. In addition, I expected more support when we are requested to deliver student-centered learning. For example, I usually get a class schedule of 50 minutes each class; this makes PBL very difficult since we had to spend time moving around tables at both ends of the class. It would be more efficient to have a 1.5-hour schedule for PBL sessions so students could take time to work on their projects. But my request was not fully supported by the departmental system, although at the college level the PBL practice was encouraged. I felt squeezed between two layers of institutions. (UE interview 4)

Despite gaining experience in PBL and a positive evaluation from the students, UE decided to take a break from PBL since, as he explained,

> I feel so exhausted, both physically and emotionally. Implementing PBL was great and I enjoyed seeing the students' results, but the institutional challenges drained my energy and I feel I have been fighting all the time and now I am so tired I need a rest. Giving lectures is the easiest and safest way to be a university professor. I should keep in mind that I am also an engineering professor with many engineering projects requiring my attention. (UE interview 5)

After UE made this decision by end of the second semester, his colleague KN became dean of the college of engineering. KN not only encouraged the entire college to implement PBL but also continued to implement it himself as an instructor. With this encouragement, UE quickly adjusted his decision and chose to use a PBL approach again for his next course. Nevertheless, in order to avoid more negative peer judgement, he provided even more direct input through lectures (more than half of the course contact hours focused on lectures, and around 40% of class time was used for PBL sessions) in addition to the project work. His goal in doing this was to 'ensure [students] receive as much support from me as possible in addition to their project work.' During this semester, the departmental stance on implementing PBL was adjusted to be consistent with the college's overall perspective. The doubt from colleagues about whether PBL would help learning was muted. Following the institutional vision of PBL, UE became an active member of the task force to support colleagues in PBL implementation. Nevertheless, he still retained concerns about facing potential doubts and judgement from colleagues, and he emphasised the importance of 'providing sufficient lectures to ensure students are learning the basics in addition to their project learning' (UE interview 6). After these experiences with PBL implementation, UE hopes to maintain his profile of 'being an internationally well-known researcher in structural engineering with added value of expertise in educational innovation and research.'

KN

In his first experience of PBL implementation, KN rescheduled his twice-weekly class sessions as one lecture session (75 min), in which he introduced relevant theories to students, and one PBL session (75 min), in which he functioned as a facilitator supporting team project progress. The evaluations reported that students were highly satisfied with the course method due to KN's rich experience in the industry and workplace, and they also wanted more time to work on projects with a larger scope. Following this suggestion, KN revised the second PBL course so that he introduced the project in the first weeks and invited three engineers from the field to provide support as project mentors over a period of one month. This was further revised by increasing the project grade from 70% to 100% in the third PBL course, with an assessment model of 70% for the team project and 30% for individual learning. For him, the choice of topic and problem formulation is the key to success in implementation; for example, he stated,

> Building Information Modelling (BIM) was a successful topic, since it has many technological tools and packages that associate with industry practice and facilitate teamwork engagement … to further ensure success, it has been very useful to provide students with clearly defined rubrics in detail at the project start so they know the goals and ends. (KN interview 1)

Teamwork was a skill that was emphasised in his course. He often invited students to instruct one another so that they could share strategies among groups. Learning from the first two experiences, he also emphasised the importance of monitoring the project's process in stages using milestones. He said that 'inviting our former students now working in the industry to work as mentors is also useful to help students see how it is in real work life.' (KN interview 4)

Similar to UE, KN also mentioned the challenge of time demands in implementing PBL, such as preparing learning resources, contacting outside experts, and providing comments to each group. Also, like UE, he faced challenges in scheduling (50-minute classes) and with in-classroom facilities (inflexible desks and chairs), reflecting that 'there are issues we do need to improve and get

solved to better implement PBL, but I try to focus on the positives and ignore the negative things, try to listen to students' feedback and keep on going.' He did not reveal any doubts or frustration in his vision of expanding PBL as a pedagogical strategy for the entire engineering college. He remained decisive in his strong belief that PBL would be the most appropriate pedagogy for engineering education and that he just needed to find the most suitable way to implement it. To motivate his students, he invited industry representatives to visit them and offer tutorship for student projects. He adjusted his assessment and grading methods each semester to maximise the value of the project learning outcomes.

Prior to the third PBL course, KN became the dean of the college. Despite this full-time administrative position, he decided to continue teaching his course with PBL implementation in order to make further improvements. As he said, 'each time I have practiced PBL, I learned how to plan it better next time, what content can be removed from the class hours when they are beyond the project scope.' During this semester, his class schedule changed from 50 min per session to 1 h 20 min, which provided more space to conduct PBL activities, such as group discussion and tutor support. Industry professionals were invited to serve as tutors, a role he also took on himself. All course lectures and assignments were adjusted to support the overall project work. More satisfactorily, he justified his previous practice of balancing the rubrics and assessment methods, with 70% of the overall grade for team projects and 30% for individual learning in relation to the project. He reflected that 'working toward the improvement of assessment each semester was really a good learning process for me and a breakthrough this time.' (KN written reflection)

In his role as dean, he also called for a future expansion of PBL practice within the college and set up a task force to prepare for future institutionalised implementation. As he expressed it, he did this because he believed that PBL would be an ideal strategy to 'facilitate engineering students with industrial engagement, to enhance their communication skills and improve their ability to work as part of a team,' as he stated in the last interview.

Combining his roles as an engineering instructor, engineering researcher, and educational leader, KN considered it highly essential to be involved in more pedagogical research in order to provide evidence to lead further change. Seeing his role from an institutional perspective, he also shared the challenges he faced in enacting change at a larger scale, including how to gain more buy-in from colleagues and how to receive more support from university leadership to balance the overall structural constraints, such as accreditation requirements, with the expansion of PBL implementation from course level to an integrated curriculum. As he explained,

> On one side, we shall convince more colleagues this is the way to go and to bring in department level support, which is a short-term goal, and at the same time we shall also explore an institutionalized framework and approach to maximize PBL implementation at a curricular level, which is a long-term goal. Fundamentally, we shall also deal with our culture, in which many people still believe lecture is the best way to learn. This has been prevailing for over 40 years and still serves as a basis for resistance … we need more research evidence to change this cultural belief. (KN interview 6)

JP

JP applied for a study-abroad grant from the national scholarship council, which was a programme supporting faculty development for universities in economically less developed areas in western China. She chose the PBL professional learning programme in Denmark due to her interest in pedagogical innovation. After she finished her PBL training programme in Denmark, she was expected to pilot what she had learned and later train other colleagues. As the first pioneer to use PBL in her home institution, she applied for approval to innovate her course under the following conditions: first, she divided her class of 120 students into two sub-classes to make space for PBL activities; second, she obtained permission to use assessment methods that differed from the standard methods (which are usually knowledge-testing-based and summative).

With a well-prepared PBL design and action plan, she was ready to move into the implementation process. But it did not take long before she realised that there was a gap between her design and

student acceptance. She designed a real-life problem as a theme, inviting students to identify issues and aspects to improve in certain technological systems of local pharmaceutical companies. But since she did not have an advance agreement with the companies, students experienced difficulties accessing those systems. She had to adjust the project scope and introduce certain cases from her own research projects instead of letting students explore real-life problems on their own. Although the class was divided into two, supporting six groups of students with ten in each group during each class was also a challenge. During the two-hour sessions each week (14 weeks in total), she scheduled the contact hours to include both lectures and group discussions on projects. But this was far from enough time for students to progress on their projects, so most of the work was conducted in their out-of-class hours.

A student's overall grade was divided into three components: online reading and discussion participation (20% of the individual work grade), group project report (60% of the group work grade), and oral presentation about the project (20% of the group work grade). In order to encourage her students to read and discuss material from diverse sources, she provided reading materials that were part of the formative assessment online. However, she found that the students mainly used the online reading for required, graded assignments and not to do research for their team projects. The students also revealed this in their evaluations. Based on this result, JP removed this assessment tool.

To share her experiences, she invited professional teaching evaluators in her university to observe her PBL sessions, but this ended up dampening her enthusiasm. She explained:

> I could see they used different criteria to evaluate a student-centered learning initiative. I was criticized for not giving sufficient information on the blackboard, which was an important value for being a teacher in my university. I was lucky that I had a good reputation of being an experienced and excellent teacher, so they could not criticize my teaching too negatively as they often do to others, but still their judgment was not in line with the idea of PBL. I still have to work on that to get it accepted. (JP interview 2)

After the first PBL semester, JP's student evaluations reflected positive attitudes and acceptance as well as evidence of improved deep learning. However, JP self-evaluated her first experience as unsuccessful and unsatisfactory. As she stated during the interview at the end of the course,

> I was not totally satisfied; things did not go as I expected … maybe it is because of the class size; it is still very energy-consuming to organize group discussions with 6 groups of students with 10 students in each group every class. To be honest, each time after the two-hour class I was exhausted. Not to mention having to do this twice. But still it was not enough for students to get the support they needed. Sometimes I met them in my spare time to support their projects, but I could not spare more time. In the future I should ask for a workload reduction so that this PBL course could be counted as two courses, and hopefully I will have more time with students.

JP's second PBL course was a small course of around 30 students, and in her words, implementing PBL with a smaller group of students was a 'mild' experience. This gave her more time to organise classroom discussion and support project progression. She also took it as an opportunity to compare students' experiences and outcomes. Comparing her experience of implementing PBL in this course (30 students) with the previous one (120 students), she perceived it as 'more relaxed and easier to manage.' Afterwards, she reflected that 'I feel like I'm doing an experiment all alone without knowing whether I am doing it correctly or not; I need a chance to breathe, to think and learn more in order to develop better PBL strategies for the future.' (JP interview 4)

In the third PBL course, JP included activities that supported local students, such as online individual learning resources, assessment tools, and supportive activities to facilitate team dynamics. As she wrote in her final reflection:

> Adjustment is highly important in the process because our students in China expect a lot of delivery of hardcore information from the lectures and they are surrounded by lectures; if you don't give them, they will get disappointed. Therefore, I developed activities combining giving information and helping them to learn on their own.

She also learned to be positive about her experiences, even the challenges, as she stated:

> Sometimes I got a lecture hall as classroom where the desks were fixed; I had to apply for a different classroom so we could move the desks around. This semester I decided not to take that trouble anymore and just take it from there and try to organize classroom teamwork in whatever conditions we had. Maybe we can do student-centered teaching no matter what conditions we have; at least I am trying to work on this now. It has been too much effort to apply different things, and I don't want them to think I am difficult by doing pedagogical innovation. (JP interview 5)

After three semesters, JP developed an appreciation for her adaptation strategies through continual engagement with professional learning:

> I read through many videos and literature to get advice on how to support teamwork in a big class of 120 students … it is not easy, but I think when I help students to analyze different scenarios—for example, on team formation—should they go for homogeneous strategy or diversity, I can see they think about it and discuss before they make choices and decisions. They grow from this process. (JP interview 6)

Following these PBL experiences, JP saw herself as doing 'more like what a real educator should do' in addition to being a researcher in her own field. Nevertheless, she expressed her concern about the effect of educational change, as she said:

> I feel that all these efforts are meaningful. I received the government grant to learn PBL in Denmark and I have tried my best to implement it and to share with other colleagues. But I don't know to what level this helps make things better educationally. You know, our system is the same and our culture is the same … I feel powerful when seeing the effect on the improvement of my students' learning, but at the same time I also feel powerless when I see little change in the overall picture of our education system … we need more knowhow, more people to join this change initiative and more support from the system. (JP interview 6)

4.3. Agency-on-Prospects and future orientations

Emerging themes in this stage include not only the instructors' prospective consideration about their own development, but also their consideration of student and institutional development. We note that UE and JP, despite their small 'breaks,' were both determined to carry on with their PBL experiences. They both resigned from their administrative positions and planned to focus on their own research and PBL practice to further develop their expertise as both engineers and educators. As JP noted in her written reflection:

> Doing lectures is the same across semesters, but doing PBL is different every time. We have to think about who the students are and design for the students and adjust along the way. Lots of decisions are needed. I like it and it is interesting and challenging. I feel I am useful in helping them to learn instead of just delivering information … I was so touched when my students used the word JOY to describe their learning in PBL. This made me happy and I will certainly go ahead.

All instructors stressed the importance of institutional support to further succeed in PBL. As a dean, KN established a vision for an institutionalised PBL method, and in near future, the goal is to invite more colleagues to join the effort to change and to establish an effective institutional PBL model that suits the context of the college and Middle Eastern culture. As he noted,

> Now I have learned that there is no good PBL, but I need to act according to the situation. I learn by doing and practicing it, and each time I improve by reading the literature, observing reactions and outcomes of students; in particular, the results of our common educational research showed me evidence of what I did …

JP had modest expectations and hoped for acceptance of her continuation of PBL. As she summarised in the last interview:

> I think the best support is that they did not stop or interfere with me implementing PBL although I do not always follow the rules. For example, lesson plans with provided templates … it made it very difficult for the young instructors to do anything student-centered … I was lucky in a way that by being an experienced teacher and being the director of the graduate school, they respected what I did differently from others.

At the same time, her recent efforts also include inviting a few of the newer teachers to join her in exploring PBL practice in the coming semesters.

For KN, engagement with pedagogical innovation is an essential aspect of his leadership at the college level. He also engaged with the team (including UE and the PBL mentor) to work on an institutional framework to enhance PBL at a larger scope within his engineering college.

Both UE and JP, based on the success of their own experiences, made efforts to influence colleagues and expand their individual efforts in relation to team and institutional development.

5. Discussion

Professional agency is closely connected to professional identity, which is reflected in teachers' perceptions of themselves as professional actors, their views on teaching and learning, their perspectives on their career paths (Vähäsantanen 2015), and their relational interactions with students, colleagues, and the work environment. In this study, while the instructors shared various pressures and challenges in their work environment, as reported in previous studies (Jääskelä, Häkkinen, and Rasku-Puttonen 2017; van Barneveld and Strobel 2011), they demonstrated a positive attitude and competence in developing the agency to manage these tensions. To answer the first research question, based on longitudinal qualitative data derived from our study, we can conclude the following about the development of teacher agency in the context of pedagogical change, following the three different phases of such change.

In the **agency-for-action** period, despite their different drivers, the instructors shared the same passion for teaching and caring for students, which served as a strong base for their enthusiasm for pedagogical innovation. Their voluntary participation in professional PBL learning activities motivated them to be devoted to the practice of PBL implementation. They built strong beliefs that PBL would be appropriate and beneficial for solving existing educational issues in their environments (students' lack of motivation and profession-related skills such as problem-solving, communication, and teamwork). In addition, the instructors believed that engagement with PBL would be an opportunity for their own professional development, conferring the additional value of pedagogical expertise and developing their institutional profile (Kolmos and Holgaard 2019). These beliefs transformed into a strong driver and motivator for their decision to practise PBL (Assen et al. 2016; Biesta, Priestley, and Robinson 2015) and for their dedicated preparation. To prepare for PBL implementation, they modified the teaching designs and action plans developed from their PBL training to suit their prospective courses, justified assessment methods following the principles of constructive alignment (Biggs and Tang 2011), and worked with a pedagogical expert in PBL (the PBL mentor) to discuss the anticipated implementation. Their efforts in relation to their own professional learning and preparation for PBL supported their confidence in their stance, actions, sense of agency, and competence to reach their target goals (Bandura 2006; Biesta, Pristley, and Robinson 2015).

These findings differ from the findings of previous studies, which determined that teachers lack motivation to implement PBL as part of a top-down systemic approach to change; this lack of motivation arises from their lack of understanding of PBL and their lack of efficacious skills required for its implementation (Du et al. 2019). These contrasting results indicate that instructors' motivation and readiness for change are influential in effective implementation (Assen et al. 2016; Du, Naji, et al. 2020) and in the renegotiation of their professional identities (Vähäsantanen 2015).

Nevertheless, looking back, the instructors also recalled their 'nervousness and concerns' during their first semester. As they reflected, even though it was highly essential to have a sense of purpose with clear goals and plans (Pantić 2015) and being prepared with the requisite skills was the key to implementation (Du and Chaaban 2020; Mitchell and Rogers 2019), they could not predict what would actually happen, and so their first experience was challenging and fraught with feelings of insecurity (Al Said et al. 2019). They had concerns about how their pedagogical innovation would impact student learning; in addition, working in a bottom-up mode, they were concerned about

how others would evaluate their performance (Du and Chaaban 2020; van Barneveld and Strobel 2011; Sabah and Du 2018).

Regarding **agency-in-action**, the multiple sets of longitudinal data gathered during the three-semester-long implementation provided insights into how an individual's professional agency embodies the choices and decisions made during the implementation process, including how they generate meaning in what they do, how they associate with others, and how they take purposeful actions to initiate change and handle conflicting perspectives in their given socio-cultural contexts. As stated by Vähäsantanen (2015), a teacher who develops professional agency creates opportunities to influence their own work by negotiating not only the content but also the conditions of their teaching. In this process, the instructors developed engagement cognitively, behaviourally, and emotionally (Wilcox and Lawson 2018). They engaged in diverse professional learning through reading PBL literature and discussions with the pedagogical expert. They adjusted their practices in classroom activities and assessments each semester in order to maximise the value and effect of PBL. In addition to taking strategic action and assuming perspectives or ways of thinking to accomplish goals (O'Meara 2015), the PBL implementation process also involves developing resilience and autonomy through adjustment (Wilcox and Lawson 2018). Facing the various challenges and constraints in their PBL implementation, the instructors demonstrated different strategies to negotiate those conditions, such as developing teaching and learning resources of their own (e.g. KN used his personal network to invite industry professionals to class, and JP prepared reading materials on her own initiative).

The outcome of the study also suggests that the development of **agency on prospects and future orientations** was intertwined with instructors' engagement with reflection and evaluation. The instructors did not take what PBL should be for granted; rather, they tried it out by initially following the principles and then adjusting along the way to align PBL to their own students and environments. Their constant reflection also developed their ability to act in new ways and even resist external norms and regulations that were in conflict with their beliefs and goals (Toom, Pyhältö, and Rust 2015). In addition, the instructors critically reflected on their practice in the process, not only through experiences but also through engaging in the scholarship of teaching and learning in a research-based approach (Kreber 2006). Each semester, the co-authors worked on a collaborative research study investigating student learning outcomes in the given PBL context, and the results were used to improve the next PBL course (see Du et al. 2019; Du, Naji, et al. 2020).

The PBL implementation process was also a process of transformative learning for emancipation and empowerment (Mezirow 1991). As Neumann, Terosky, and Schell (2006, 115) noted, 'agency requires thought, reflection, learning through trial and error, creativity, continuing assessment, and no doubt, persistence and courage' (115). Hence, educational research is a way for instructors to not only conduct critical reflection and evaluation but also to reshape their professional identity from being an engineering researcher and instructor to a 'real educator,' an 'educational researcher,' and an 'educational leader.'

To address the second research question, in highlighting the interplay between individual professional practices and socio-cultural practices, this study has also identified how individual resources and social conditions frame the enactment of professional agency (Pantić 2015; Vähäsantanen 2015). First, we identified participation in professional learning activities and engagement with educational research as the most valuable internal supporting resources and as powerful tools for enhancing instructors' motivation, beliefs, and critical reflection of their teaching practices, which contributed to their self-empowerment for transformation (Mezirow 1991). These findings contribute to the literature by providing evidence that instructors' engagement with professional learning and pedagogical research are useful sources for their reflective practices, and these practices, in turn, enable their transformation. For instance, JP, who had more professional development experience with PBL (6 months), demonstrated significant pedagogical reflection, relating her own experience as a PBL learner to her justification of PBL practices in

her classroom. This reflection demonstrates her transformation from engagement to progressive reflective actions (Du, Spliid, et al. 2020).

Second, interactions with students and staff/faculty development activities were strengthening factors for both UE and KN, who worked collaboratively to develop collective agency (Hökkä, Vähäsantanen, and Mahlakaarto 2017) throughout the PBL implementation process. For JP, on the other hand, a lack of opportunities for such interactions became a constraining factor that led to feelings of loneliness. Third, mentorship (i.e. support from the pedagogical expert) was viewed by all of the instructors as a valuable resource to empower and enhance their beliefs and confidence in the change process, their choice-making and decision-making, and their reflective practices, which is another factor that has not yet been addressed in previous studies. Last but not least, institutional support factors, including but not limited to class scheduling, classroom facilities, and space for adjusting assessment methods, were mentioned by all instructors in this study as constraints during the initial stage of their implementation. This suggests that if these factors are positive, they may help motivate instructors to engage in the process of change (Naji et al. 2020). These institutional support sources and constraining factors also explained the temporal nature of teacher agency (Eteläpelto et al. 2013; Hökkä, Vähäsantanen, and Mahlakaarto 2017); for instance, UE and JP expressed their frustration with institutional setbacks and KN further developed proactive strategies after obtaining his deanship.

As suggested by Shekhar and Borrego (2017), it is meaningful for teachers to not only identify challenges but also to develop strategies to overcome them. Two of the major strategies reported in this study are (1) focusing on the goal of educating engineering students, who are better prepared for the professional world, and (2) valuing one's participation in educational research, as it contributes to their identity as a university researcher and an engineering researcher. In contrast with the results from previous studies, which found that university instructors prefer to see themselves as scientists or disciplinary experts rather than as teachers (Brownell and Tanner 2012), the instructors in the current study were proud of developing expertise in pedagogy and in particular of being educational researchers in addition to being engineering professors. Rather than feeling devalued in their professional identity (Brownell and Tanner 2012) or living with adaptations (Toom, Pyhältö, and Rust 2015), they developed an appreciation of a multi-faceted professional identity in engineering (Morelock 2017), which can be seen as another indicator of self-empowerment in agency development (Eteläpelto et al. 2013).

To summarise, the supporting and constraining factors and coping strategies identified above have implications for the guidance of educational practices in supporting a systematic approach to pedagogical change that engages more instructors. The engineering instructors' interactions with their institutional environments are complex, including multiple resources and demands in relation to student learning outcomes, institutional expectations, and individual teachers' need for peer support and institutional facilitation (physical environment and classrooms, class schedules, autonomy in assessment methods, and evaluation criteria for the faculty). The instructors all struggled, compromised, and found their own ways to be resilient and persistent in their innovation processes, despite both the strengthening and the constraining impacts of their direct work environment (Van Lankveld et al. 2017). In particular, the results suggest that developing resilience is necessary to sustain the change, which requires a capacity to maintain equilibrium in the midst of difficulties and preserve a strong sense of agency and commitment to the target goals (Wilcox and Lawson 2018).

The study has a few limitations. First, its small scale means that it is difficult to generalise widely, although we have tried to leave the reader room to broaden their perspectives on the issues presented here. Nevertheless, we hope that small-scale events in everyday life can illustrate features of broader social processes, and that a longitudinal report consisting of descriptions and accounts can reliably represent a social world in which people make sense of their everyday lives (Mellstrom 1995). Second, the dual role of the authors, although it is in one respect a strength because it engages engineering instructors with education scholarship via classroom research (Cranton 2011;

Kreber 2006), is also a weakness due to potential bias, as previously discussed. Third, while the inter-pretivist approach to analysis has been considered powerful because it reveals the subjectivity of human thought in order to study the process of creating agency (Edwards 2015), the results remain provisional and highly contextual due to the small size of the current study at hand. Further-more, the study did not explore in depth the types and forms of PBL that the instructors implemented, which may have been related to their agency. For instance, a progressive approach to implementing PBL at the course level can support student engagement in an educational context where teachers remain the authority of knowledge (Naji et al. 2020), and implementing such a progressive approach would entail further research.

In addition, the multiple rounds of data analysis both inductively and deductively corrobo-rated our conclusion that the framework proposed in this study can guide the understanding of agency development and the identity-reshaping process engineering instructors undergo when implementing pedagogical innovation such as PBL. However, future studies with a more mixed-method empirical approach are necessary to further examine the framework. Future studies may also focus on variations in agency development, comparing diverse social, cultural, economic, political, and educational environments. While instructors in this study highlighted the impact of their respective cultures on student learning, institutional policy, and their own choices and decisions, and while they used individualised coping strategies, developed their own pro-fessional agency, and renegotiated their professional identities, our focus was more on the com-monality than on the diversity of their experiences. In sum, we acknowledge the methodological weaknesses of this study and have tried to focus on the 'experiential, presentational, prop-ositional, and practical knowing that lead to actions to transform the world' (Guba and Lincoln 2005, 196).

6. Conclusion

The study contributes to the literature surrounding teacher agency by providing a conceptual frame-work guiding an understanding of the professional agency of engineering instructors in the context of pedagogical change. The study also makes a methodological contribution to the literature by pro-viding empirical data that shows how engineering instructors make choices, take action, cope with challenges, and renegotiate their professional identity from a longitudinal perspective during a process of implementing PBL over 1.5 years.

The outcome of the study provides insights into how the instructors recognised and responded to demands through their engagement with critical reflection and scholarship on teaching and learning. The observation of teachers' negotiations with both individual and social resources and conditions may provide a better understanding of the temporal nature of teacher agency. This understanding will, in turn, lay a foundation for examining the long-term professional agency of teachers at the community and organisational levels. In general, the outcome of this study suggests that it is an added value for engineering instructors to become agentic professionals in balancing their identities as engineers, academic researchers, and educators engaging in sustainable pedagogical development. While most works provide a less progressive and positive portrait of teacher agency (Brownell and Tanner 2012; Campbell and O'Meara 2014; Vähäsantanen 2015), this study highlights the positive and creative initiative of the manifestation of professional agency. By highlighting the positive side of the instructors' overcoming challenges and developing agency in the process of engaging with pedagogical change, this study also may serve as an encouragement for more university teachers to be com-mitted to innovating university teaching and learning. Lastly, the results of this study demon-strate the importance of understanding the relationship between the professional agency of individual instructors and the multiple demands of their social and institutional contexts. Thus, it calls for further research attention to professional agency in engineering education and higher education in general.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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