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Engineering Teachers' Professional Learning and Role Identity Change in An Intercultural (Study-Abroad) PBL Programme*

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This study follows three Chinese university instructors' learning and role identity change in a six-month Problem-Based Learning (PBL) professional learning programme in Denmark. Data sources include individual progressive portfolios and two rounds of interviews. Data analysis using the *Dynamic Systems Model of Role Identity* indicates that all three participants experienced change in all four dimensions of the model: ontological and epistemological beliefs, purpose and goals, self-perceptions and definitions, and perceived action possibilities, resulting in changed teacher role identities. Furthermore, the role of the intercultural context of the programme in triggering enablers and/or constraints for learning was also studied. It was found that beliefs about cultural community and "othering" in some cases acted as initial triggers for learning and motivation, while, in other instances, beliefs about cultural differences could be a constraint. The results provide evidence of the effectiveness of using a PBL methodology to organise professional learning activities and facilitate teacher role identity change and explore the roles of culture and interculturality in relation to the DSMRI model.

Keywords: Chinese engineering teachers; teacher role identity; PBL based pedagogical development; intercultural/study abroad; Denmark; DSMRI

1. Introduction

Over the decades, tremendous efforts have been made to provide professional learning activities to teachers, regarding pedagogical development. The prevailing literature has provided results of such activities on how university teachers change with respect to aspects of their perceptions, attitudes, conceptions, knowledge, skills and approaches to teaching and how their changed teaching practices resulted in students' perceptions and approaches to learning and outcomes of learning [1–3]. Nevertheless, these research results remain inconclusive [2] which can be related to the fact that the way teachers learn is a complex matter, involving interactive relations of multiple aspects for a teacher including one's own prior experiences of learning and teaching, personal cognition, motivation, efficacy, values, relationships with peers and with their institutional surroundings [4]. In addition, the linear way of thinking how teachers learn from professional learning activities has been criticised due to the separation between theory and practice, the advocation of a universal reality for teaching practices and lack of inclusion of contextual factors for teaching and learning [5]. Therefore, research on teacher learning should take into account the complex teaching system, considering non-linearity, variability, and contextual sensitivity in process and outcome [6].

In this article, we explore how university teachers learn from a pedagogical development programme. We take our conceptual departure for how teachers learn by adopting a complexity theory which provides a lens to support our views on teacher learning from the perspective of a nonlinear and complex

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dynamic system [4, 5, 7, 8]. From such a perspective, teacher learning is unpredictable, dynamic, and contextualised, involving multiple interactive, personal, relational and institutional factors [7, 9]. In a complex and dynamic learning process, teachers negotiate and renegotiate their identities, regarding who they are, what they believe and what they want to achieve as a teacher [10, 11]. Accordingly, the ways that teachers reform and reshape their beliefs about their professional identity roles are essential as a way to understand their learning from professional activities [6, 12–14,] and, at the same time, a lack of a sense of renegotiated identity about what it means to be a teacher would limit their motivation to engage in changing their practices [7, 11, 15].

In this study, we empirically explore Chinese university engineering teachers' learning in a six-month professional learning programme in Denmark, focusing on their change of role identity. A longitudinal perspective was taken to report change processes including multiple data sources from three participants from the cohort of the 2018–2019 programme. Supported by an institutional agreement by the China Scholarship Council and Aalborg University, a study-abroad programme was established to provide Chinese university teachers the opportunity to develop pedagogical competencies, focusing on the methodology of problem and project-based learning (PBL).

Our previous research, from an earlier cohort of this programme, reported positive results regarding participants' meaningful learning about PBL through experiencing PBL as learners, improved critical reflection for transformative learning [16] and changed pedagogical beliefs and intended practices towards learner-centred modes [17]. Nevertheless, the studies also found that some participants reserved their beliefs about themselves as major authorised sources of knowledge for students, which limited their further changes in intended practices, for implementing PBL [16, 17]. These unchanged beliefs were attributed to the institutional policy and cultural ideology of being a teacher in China. Therefore, in this study, we further explore how learning takes place through the lens of role identity change in an intercultural context, in addition to the complex dynamic system of the role identity formation of the teachers.

The social-cultural role of a teacher is deeply embedded in cultural understandings and it is negotiated and enacted in specific social contexts by individuals. As such, this dialectic characteristic means that culture can be seen as a resource for identity formation [18, 19] and intercultural experiences as catalysts of change, offering new knowledge and configurations of such roles while, at the same time, framing experiences and guiding actions, which can potentially result in cultural resistance [16, 17, 20]. In this connection, it is important to stress the diversity and richness of national cultures that, in themselves, can offer different and, at times, conflicting ideals of a 'teacher'. Thus, the role of culture in a complex system cannot be predicted but only analysed [21]. We found that this perspective of the intercultural context of professional learning programmes is relatively unexplored.

2. Theoretical Framework

2.1 Learning and Culture from a Complexity Theory Lens

Complexity theory, addressing change, adaptation, development and evolution, involving multiple components interacting non-linearly in a system, has recently been adopted in educational settings to understand change, providing an organic and holistic approach to examine a phenomenon instead of looking at the world in a simplistic cause-and-effect and linear way [22, p. 22]. Complexity theory provides a lens to understand education and learning as a whole, comprising relationships, integration between many factors and their interactions with the environment, rather than focusing on individual, isolated factors and parts of the whole [23]. From this perspective, educational change is closely associated with ambiguity, instability and unpredictability [24].

Complexity theory views learning as a dynamic, active, experiential, participatory, and autonomous network involving diverse aspects of cognition, such as efficacy, affect, motivation, and self-regulation [22]. In a curriculum design incorporating complexity thinking, such as PBL, learning is seen as dynamic, emergent, open, relational, self-organised, and connected through the interactions between parties [5]. As such, in a complex learning environment, learners take agentic action by intentionally engaging in exploring their identity (intrapersonal), when new content presents itself through social interactions (interpersonal) in a specific context and time [7, p. 6]. Concepts such as creativity, collective knowledge, and a learner's ability to handle uncertainty and emergent change, rather than emphasising standardised knowledge and individual performance are also underlined to promote learning [22]. The traditional role of teachers as the masters of authorised knowledge is therefore challenged and, instead, teachers are also learners and co-constructers of meanings and co-creators of new knowledge [22]. This understanding of learning fits well with the PBL approach. The abbreviation of PBL stands for either problem-based or project-based learning. While the terms 'problem-based

learning' and 'project-based learning' are inevitably connected and often used interchangeably in the literature [33], it is not the intention of the current study to distinguish between these two terms. Rather, we take an integrated approach to PBL, merging the characteristics of problem and project-based learning. In particular, PBL in the current study is defined as encompassing three major elements: (1) using problems as the start of learning, (2) using projects to organise the learning process, and (3) learning in a teamwork setting [34, 35], which ensures a clearly structured student-centred and sociocultural approach to learning that are in line with complexity theory.

From a cultural aspect, the sociocultural understanding of learning, as a largely social process [18], is closely linked to identity formation and change [25]. Construction of identity is situated in and between the communities of practice (CoP) that we are part of and participation in such communities not only inform us on how to act, but also on how we understand the way we act and, ultimately, who we are in the sense of social role identity [26]. The intercultural context of the programme entails a complex cultural environment, where new CoPs based on hybrid understandings of role identities, such as the 'teacher', might emerge, that participants might, or might not, align with. With regard to the latter, what has been less explored is how CoPs and boundaries can also, largely, be a source of resistance against change and learning [27]. Wenger [28] describes "the mystery of 'otherness' " found in other CoPs as 'exciting and attractive,' implying a potential for learning. Within research on interculturality however, 'otherness' and 'othering' have led to much more polemic debates surrounding issues of racism and culturalism [19]. However, in what conditions and in which ways 'otherness' becomes a catalyst or resistance to learning in professional learning programmes remains to be explored in depth.

2.2 Teacher Learning and Role Identity Change

In this study 'professional learning' is used to refer to university teacher learning activities through which the teachers participate to enhance their teaching and learning, and to highlight the learning process teachers experience when extending their knowledge, beliefs, skills, and practices [3]. In particular, the way that teachers learn from a professional learning programme/activity can be understood as their 'changes in knowledge, orientation, and skills that pertain to the person's conception of teaching and actions as a teacher' [30, p. 8].

In their review work Russ, Sherin, and Sherin [6] summarised that research on professional learning overemphasised four aspects: subject-related knowledge, knowledge of pedagogical content, theories of teaching and learning and instructional strategies. Therefore, important additional factors that contribute to a teachers' change of pedagogical beliefs and practices should be incorporated in the conceptualisation of teacher learning. In particular, teachers' worldview, values, and beliefs about education, their individual interests, motivation and perceived efficacy to develop strategies according to diverse learners, and their perceptions about and interaction with their institutional environments are all essential to their choices, decisions and agentic actions [7, 8]. Therefore, emotions, perceptions of their experiences, sense of satisfaction and negativity are highly relevant to how they learn from a professional learning programme and how they potentially change their prospect practices [7, 8, 10, 12]. Teachers' professional practices are influenced by their learning and their self-related beliefs, perceptions, emotions and personal stories which, in combination, constitute their perceptions of being a teacher [11, 13, 14].

While research on teacher learning focusing on their identity formation and negotiation in K-12 contexts had attracted increasing attention, literature on university teachers is mainly focused on their academic path in general [31], with little emphasis on their teacher role identity. In their systematic review work, Van Lankveld et al. [32] found that many university teachers experience reduced self-efficacy and motivation, competitive relationships with colleagues, and confusion about their professional identity, in the context of institutional requests for pedagogical change in their daily practice. This is in addition to pressure to develop academically and be promoted within the university. When teachers have the opportunity and flexibility to negotiate their identities through their professional learning, they may experience increased commitment and motivation to change [9]. Therefore, there is a need to understand and explore how university instructors navigate their professional learning and renegotiate their role identities for pedagogical change.

From a complexity theory perspective, the teacher role identity is conceptualised as a complex dynamic system, encompassing a network of interrelated components that are dynamically emerging [4, 6]. Accordingly, there is no single factor or dependent factors influencing the construction of teacher role identity but, rather, the role identity of being a teacher consists of interdependent elements, manifesting reciprocal influences with its environment [8, 10].

Change in role identity is central to the teachers' learning and is highly dependent on the state of the learning system and its interaction with their envir-

onment. In the dynamic systems model of role identity (DSMRI) proposed by Kaplan and Garner [7, 8] and Garner and Kaplan [30], they emphasised the centrality of role identity of a teacher in both the personal (self-perceptions, beliefs, emotion) and the social-cultural context in which a teacher lives (socialization and negotiation through their participation in the community of practice for teacher professional learning) [7]. The DSMRI model aims to understand teacher learning [7, 8, 30] by identifying four interactive, overlapping and multi-element dimensions that will be presented in this paper along with questions related to the context of the current study: (1) Epistemological and ontological beliefs, which refers to knowledge that the teacher holds as true regarding their subject domains and how to teach them in the given context, instructional strategies, and cause-and-effect (such as reasons why certain strategies work while others do not). What beliefs do the engineering teachers hold regarding what is good teaching and learning; what instructional strategies are appropriate in their situated context? What is the reason why certain pedagogical approaches are more effective? (2) Purpose and goals: which are about how teachers perceive their own roles and aims to get committed in teaching. What are their goals (intrinsic and extrinsic) and intended practices and achievements of working as engineering teachers at university? (3) Self-perceptions and self-definitions – teachers' perceptions and knowledge of their own personal and social attributes, self-defined characteristics and group memberships and how these are relevant to the teaching role. What are their motivations, efficacy and aims to learn and improve their pedagogical approaches? How do these teachers perceive themselves as a member of the community for practicing pedagogical development? (4) Perceived action possibilities, regarding what the teacher can and cannot do to achieve their goals in teaching, in light of their epistemological beliefs and self-perceptions. In addition, cultural and social context are key for defining the ways that a change of teacher role identity may happen, which is impacted by how they perceive the role of their subject domains, personal dispositions, interaction modes with others (teachers and students), institutional facilities and policies, and cultural norms and expectations at a larger societal scope. In which ways do the engineering teachers aim to apply what they have learned in the PBL programme to their home classrooms? How do they perceive the possibilities to reach their intended goals and how do their home environments support or constrain their changed beliefs and perceptions resulting from the PBL programme? Emotions are tied to all four of the dimensions. Thus, role identity formation processes are always contextualised and occur in a combination of social interaction that introduces new content and, at the same time, scaffold change in interrelations and agency of teachers, which is exactly what the professional learning programme of the current study aimed to facilitate.

In this study, we are not only interested in knowing how changes in the engineering teachers' learning from the given PBL programme take place but, in particular, we intend to explore how the potential change is influenced by the situated culture (the integration between the social contexts and interactions within the programme in Denmark and their home culture, where their actual teaching practices take place).

Driven by these questions, this study will be guided by the following research questions:

(1) In which ways can changes in an engineering teacher's role identity be framed and identified in a PBL-based pedagogical development programme?
(2) How do beliefs about cultural community and identity enable and/or constrain teachers' role identity processes in an interculturally situated professional learning programme?

3. Methodology

3.1 Research Context, the PBL-based Intercultural Programme

The programme has the following stated objectives: (1) to critically reflect on university pedagogy, in general; (2) to develop pedagogical knowledge and skills to support learner-centred methods; (3) to develop teaching plans and strategies to enhance PBL-inspired teaching and learning to be implemented in one's home university in China; (4) to evaluate the feasibility of implementing the new teaching design and action plan.

In practice, the programme participants attended academic activities that were equivalent to a 30 European Credit Transfer System (ECTS) (demanding 900 study hours) over six months. The following activities and assessments were designed: 10 courses were offered in the form of workshops, lectures and individual or group based assignments focusing on learning theories, PBL, curriculum design, assessment and constructive alignment. Individual participants worked on their teaching and learning portfolio, guided by the observations of the AAU-PBL model in practice, as well as team-based project work on teaching and learning issues (problems). By the end of the programme, the participants worked out a team-based project report providing solutions to their identified problems, and individual or collaborative

design (including self-evaluation) of a PBL course that could be implemented in one's home university. Participants worked in seven self-formed groups, each supported by a pedagogical facilitator (an expert in pedagogy and experienced in facilitating professional learning programmes) and a subject supervisor (an expert in the engineering field, who was familiar with the Aalborg University PBL practice).

All the participants in the programme were academic staff at the university, with engineering backgrounds. There were 24 male and 11 female participants, mostly assistant professors, and associate professors between 29 and 45 years old. The majority of participants had no prior knowledge or experience of PBL. Some had heard about PBL before attending the programme but not learned about it systematically or used it in teaching practice. While participants of the programme were expected to be able to implement PBL in their own classrooms, upon returning to China, the programme was designed and delivered using the methodology of PBL itself [16, 17].

3.2 Research Design and Participants

A qualitative research design was employed in this study, in order to understand and explore the complexity of Chinese engineering teachers' perceptions of their lived experiences prior to and during the PBL-based programme in Denmark and their perspective on how they would use what they learned after having returned to China. In particular, a qualitative case study [36] was employed for three participants from the programme, each serving as a case, to provide a longitudinal perspective on the process of how change takes place from the perspective of complex dynamic systems and role identity through their professional learning in the PBL programme [7, 8, 30]. Multiple qualitative data were generated during participants' learning processes in order to understand their subjective perceptions, experiences, discourses, emotions and reflections in given socio-cultural contexts.

Three participants, from different geographical provinces in China and representing both genders, volunteered to participate in this longitudinal study. Table 1 shows the participants anonymised names, gender, age, discipline and the titles of the courses they teach at their home universities. Empirical data from the current study came from two sources: (1) teaching and learning portfolios which included their monthly written reflections throughout the programme (comprising six sections); and (2) narrative inquiry with two in-depth interviews (mid-term and at programme end).

3.2.1 Narrative Inquiry

Narrative inquiry has been increasingly adopted in higher educational settings, to research career trajectory [37] and it was used for data collection due to its advantage of illumining a person's lived experiences and providing profound understandings of life situations [38]. The method is well-used in research, with the aim of exploring individuals perceived and subjective experiences, underlining the complex emerging social relations [39]. The life history technique to narrative inquiry, emphasising the biographical influences of human subjectivity and perceptions, provides opportunities for researchers to understand connections between individuals' intrapersonal experiences, emotions, and how they perceive their interaction with others and the social cultural contexts they live in [37]. For the reasons mentioned above, a narrative approach is particularly useful to explore how teachers perceive their professional learning through identity formation and renegotiation [13].

The study was conducted by following an outline of procedures regarding narrative interviews, integrating the techniques of a life history, suggested by Floyd [37] in his review work. The interviews consisted of a semi-structured interview, including generic biographical questions, open questions inviting participants to describe their experiences in the programme, and the specific research questions given above. Each participant was interviewed twice during the programme: mid-term and at the end of the programme. All of the interviews were conducted individually and face-to-face. During the interviews, the conversations between the interviewers (two of the co-authors) and the participants were guided by the interview questions, but with flexibility and in no fixed order [37]. In the process, the interviewers, following the suggested techniques by Kvale [40], asked one question at a time, in an open-ended format, and tried not to interrupt the participant. Sufficient space was offered to the participants to elaborate on their perceptions, feelings, experiences and emotions. The interviews took 50–60 minutes each and were conducted in Chinese

Table 1. Participant background information

Participants	Gender	Age	Discipline	Course title
C	Male	Mid 40s	Software engineering	Software engineering
L	Female	Late 30s	Bio-technology engineering	Bioengineering downstream technology
Z	Male	Mid 40s	Material engineering	Non-destructive testing technology

(the mother tongue of the participants). All interviews were audio recorded and transcribed before being translated into English by the two interviewers. The recordings were later compared with the transcripts, to ensure an appropriateness of the texts in relation to the context of the conversations [40].

3.2.2 Teaching and Learning Portfolio

The individual teaching and learning (T&L) portfolio was used in the PBL programme, as a tool to promote teacher growth through a progressive documentation of their reflections [16]. Supported by guiding questions, the participants described and discussed their teaching philosophy, backgrounds, and prior experiences, and analysed challenges in current teaching and learning practices at the programme start, providing views on their beliefs, goals and self-perceptions on being a university teacher. Later, they reflected on their understanding of alternative teaching methods, such as PBL, and reported on their participation in the programme and observation of AAU activities. They were also asked to reflect on the process of developing, planning, and evaluating suitable PBL-inspired teaching and learning activities, in relation to general and specific teaching objectives, subjects, contexts, and student backgrounds. This included reflection on the diverse educational theories and teaching and learning methods relating to their own practices and contexts. These reports, together with the narrative interviews, provided views on how their beliefs, goals, and self-perceptions evolved throughout the programme. Finally, they were expected to describe and discuss how they planned to apply what they had learned to their future practices and self-evaluation on their changes in belief, goals and self-perception, further enriched by the narrative interviews.

3.3 Data Analysis

Data is presented by providing narrative and focused description, as described by Floyd [37]. The multi-analysis approach combines the narrative data analysis and document analysis of the T&L portfolios [40]. The analysis procedures involve multiple rounds of reading texts and discussions among co-authors. Firstly, the DSMRI model conceptualised teacher learning [30] and was used to establish the initial categories, following the four dimensions for all data sources related to each participant. This was followed by thematic analysis in each dimension to identify sub-themes and categories according to their meanings in their situated contexts [40]. Then, a holistic narrative profile of each individual participant was constructed, providing an evolving process [37]. Notes were made of the significant events or instances for each participant, noting the initial impressions of the individuals' storylines and the emerging forms of role identity changes, together with the personal, relational, contextual factors influencing role identity. Finally, a cross-participants comparison was made, linking individual profiles to the DSMRI model and the participants' social and cultural contexts.

While subjectivity is the core of the narrative inquiry, the discussion of validity and even the term of 'triangulation', although well-used in qualitative studies, is also inappropriate for the nature of the narrative research [41]. Instead, we made efforts to provide 'supplements' by seeking 'richness' of data, to provide the cultural contexts of each participant, as suggested by Floyd [37].

4. Findings and Analysis

In this section, we report the individual profiles of each participant, merging all data sources (all phases of the T&L portfolio and two rounds of narrative interviews). To provide a picture of the change, their profiles are structured following the timeline of programme-start, process and end, addressing the four dimensions of the DSMRI model (beliefs, goals, self-perceptions and action possibilities) and the emerging themes from each participant.

Participant C

Background

Having a background in computer science and engineering, C used to teach different undergraduate courses including databases, C-programming language, computer networks, java server pages, etc. An ideal teacher for him is someone who cares for students and make them feel warm; in practice, he instructed students and provided them with advice. As a computer science teacher, he believed that the most important thing was to "be an excellent engineer" and be humorous and patient with students.

C did not have very clear goals for participating in the PBL programme, for him it was an opportunity to "learning something from abroad in order to bring back". Therefore, his learning process started from observing differences. He observed that the local students were highly motivated and engaged in their teamwork, unlike his own students in China, who had a very low motivation to study. During the first half of the programme, he focused on his role of being a learner in the programme. He said:

> "although we are experienced teachers in China, I feel we are just a group of students here, trying to learn different pedagogical theories . . ."

He also reflected on his own pedagogical learning about theories such as constructive alignment, constructivism, learning theory, relating to the context, for example, demands from industry, he was familiar with in China:

> "As I understand from constructivism now, the more real the more students learn. Unreal things cannot interest students. When working in industry, there is no way one can solve problems on one own, and it cannot be done without communicating with others. What is most impressive from PBL is they bring the society to the undergraduate classroom; it connects the society with the curriculum so closely."

In addition, his own experience as a learner in PBL changed his beliefs on what good learning may entail:

> "When I shared some thoughts or ideas to the project team supervisor, he usually suggested me to share this with my team members, to discuss with them and hear their comments first, then revise the idea. I found this is a good way to let the teamwork move smoothly. Instead of getting recognition from the supervisors, it is a good idea to discuss this with my team and let the idea grow in the team. It is real self-directed teamwork without the supervisor."

Programme midterm

Nevertheless, his changed belief on learning did not necessarily align with his self-perception of being a university teacher and his goals of professional learning. During the mid-term interview, although appreciating that PBL could be a good method for his own students, he did not see the need for himself to become a pedagogical expert of PBL:

> "We are different from the PBL-team here, they are specialized in PBL and pedagogy in higher education, but my major is computer engineering, participating in a programme for pedagogy in higher education is a new thing for us. We are more focused on practical aspects. What we can bring home for practices."

This tension between his beliefs, self-perceptions and goals was reflected in the limitations of his perceived action possibility and the role of domain/subject and cultural context at the programme mid-term.

> "The PBL method is indeed very inspiring for Chinese university, a lot of things to be learned . . . but if we transfer the whole set of PBL-system to China, I don't think the environment is ready for this . . ."

During the second half of the programme, C gave more thoughts about his own pedagogical belief change, and how PBL could, possibly, be implemented in his home university. By the end of the programme, C demonstrated his further change of beliefs, goals and self-perception by expressing his re-conception to learning and knowledge:

> "Before we just did the course following the instruction, sometimes without thinking much who designed how a course should be taught. . . Now I learned that we teachers shall design the course. To better design a course, it is important to rethink where is knowledge from. . . What I learned from PBL is the knowledge is from the practice and experiences . . . it is constructed by the students. . . There is no static knowledge as we used to believe. . . It changes over time and when the context changes. . . Here they talked about how to construct knowledge but in China we focused on memorizing knowledge . . . this is something we teachers all have to learn. . ."

Programme end

As a learner, C expressed clearer professional learning goals by the programme end, believing that the professional learning process about PBL could be even more effective with an "even more real" scenario, "we could have joined the local students' project team for some real projects and we may learn even more. . ."

He also theorised his own learning about PBL through this intercultural experience. For him, being a learner in the PBL environment provided him with a highly meaningful experience, compared to any training activities that could be provided via online teaching, for example. The cultural differences were the important triggers for his learning. He reflected on his own learning journey, starting from wondering about differences.

> "Why do they, Danish people, would rather pay the price to build such a system? They must have been through practices, experiences, evidence and philosophical thinking to reach the stage that they would rather persist on this. . ."

This wondering was further phrased through many questions that became his personal motivator to learning, setting up his goals with regard to what he would like to know throughout the programme. He then started reading literature, asking questions of local teaching professionals and students, observing how local students worked together (observing 500 students, as he wrote) and discussing it with his project team. During the second project teamwork, he became a "better team learner", as he self-perceived. He proposed ideas and topics to be discussed within the team and, through the research project on Chinese students' learning motivation, he got to understand his own students better than when he was in China.

He referred to his constant thinking about the complexity of learning through the second half of the programme. His self-perception and goals about being a university teacher were also connected through his thoughts about the possibility of actions:

> "My passion has been missing after teaching 11 years

> . . . mainly because nothing could stimulate me . . . now I feel my passion to teaching is up again and sure I aim to implement PBL after my return. Before I was not initiating changes, because there were too many troubles around to change anything, now I feel emotional to do something. . . PBL should be implemented in China and at least in all engineering universities. . . I am sure there will be constraints from my environment regarding how much change I can do, but I believe I have to have the wish first . . .''

In his new teaching design and action plan, constructivist theory and constructive alignment principles were used to support the restructuring of his software engineering course into a PBL mode. Despite his excitement on intentional actions to implement this design, at the end of his portfolio, he also expressed the paradox of ''should I go for it'' and ''what about the environment – will I get support on doing this?'' considering the ways his peers, colleagues and leadership would react to his ideas and practices.

Summary: Analysing C's story shows a deep change in the teacher role identity system. From having beliefs and goals that aligned with a teacher-centred way of teaching from the self-perception of an engineer to something that aligns more with an inquiry based and collaborative approach, such as PBL, and a bigger emphasis on his identity as a teacher were exemplified in his emotions and future goals. His understanding of the teacher role has changed, from focusing on intrapersonal attributes (being caring and humorous) to pedagogical thinking (how to motivate students). Tensions are seen both before and after the programme but in different constellations. In the beginning and mid-term, tensions are seen in his self-perception as a caring and knowledgeable teacher and low motivation among students in his class. At the programme-end however, tensions surround his perceived action possibilities and his changed conception of the teacher identity. This also relates to the intercultural situation of the programme. It seems quite clear that, for participant C, foreign culture and 'otherness' is a catalyst for his journey of change, wishing to ''learning something from abroad''. He also connects PBL as something inherently connected to ''Danish people'' in his pondering on local practices (only two of a total of eight universities in Denmark have adopted the PBL model), while characterising Chinese HE as not being ready for PBL and being too focused on memorising knowledge, leading to poorly motivated students. These highlights are not to evaluate participant C's reflections or their accuracy, but to analyse how the conception of the 'other' becomes a nexus for reflection and change, as well as a constraint in his perceived action possibilities showing change and alienation from his past understandings.

Participant L

Background

Growing up in a teacher-centred schooling system, Participant L was unhappy about the rigid way of learning for her as a student. Once starting in the teaching profession, she was engaged to practice teaching differently from her own schooling time. She hoped that students would ''master theoretical knowledge and apply it to practice, and play their own innovative and entrepreneurial spirit'', as she wrote at the programme start. She perceived her own role as a teacher to help students learn how to learn and become independent learners. It was also important for her to care about all aspects of her students' lives, to be able to develop appropriate methods to help them learn better. With her passion for teaching, she perceived herself as being a ''university teacher for interdisciplinary engineering courses with interests in pedagogy''. Prior to her participation in the PBL programme, she was engaged in several teaching innovation initiatives at her home university, for example, reforming the course of Bioengineering Downstream Technology, using different active learning strategies. By joining the current PBL programme, she had a rather clear goal to learn about new ways of teaching and thinking about action possibilities regarding how she could improve her practices upon her return. As she said:

> ''I was seen as a backbone of our new bioengineering programme, I have been involved in the curriculum and course development, so I had a clear goal to learn advanced pedagogy from this study abroad experience. . . I know many Chinese teachers participating in this kind of study abroad programmes aim to improve their research collaboration and profile, but I came for PBL . . . we at home already knew Aalborg Model of PBL was good for engineering education. I want to use what I learn to make our programme back home an excellent one.''

Programme midterm

With her clear goal for professional learning in the PBL programme, L was highly engaged in her studies. Perceiving herself as an eager learner in the programme, she volunteered to act as team leader for both team projects. Being particularly interested in the curriculum and pedagogy, she spent time reading literature on education and educational research, discussing it with the programme organisers.

During the midterm interview, she noted that teamwork can construct different levels of learning, as she said:

> ''in my previous teamwork experiences, either my own study abroad in other countries or common practices as a teacher in China, the ideas were usually provided by the teacher or supervisor, but in the PBL here, all

> student teams are expected to generate ideas on their own. This is a very good experience for my own learning. . . It was a hard process to agree on a new idea as a team. . ."

She was also impressed by the close industry-university collaboration in supporting students' project work. Through her observation of local students' project work, she gave many thoughts on how PBL could be implemented in her home university through inviting local industries. Right from the programme start she reflected on action possibilities:

> "The core of the problem is real life issues, as I observed here, we actually have lots of real life issues that students can use as starting points of problem work, for example the African swine fever that impacted us recently which can be a good topic for several kinds of projects. . ."

L expressed a strong awareness of her own growth through the programme, as could be observed from all her writing and midterm interview. She reflected on her change in beliefs, her learning experiences in teamwork and observation of local PBL practices. As she wrote and said, she changed her beliefs about what 'real' student-centred learning means. Before the PBL programme, what was believed to be student-centredness was more about caring for students but, in fact, the belief about what was correct was still based on "views, practices and everything said by the teacher", as she wrote in her portfolio. Her own learning in the programme changed this view dramatically, not only the beliefs but also the goals of being a teacher, as she said, is more to do with the ways that intended learning outcomes can be achieved with students being responsible. The teachers should involve professional and societal needs in the intended outcomes of the course and assess those competences and skills, instead of memorisation. She also changed her knowledge about PBL, as she reflected:

> "Previously I thought PBL was the teacher suggests on a project topic and students do it within the time . . . now I learned that it is much more complex – students have to identify problems, the problems should come from industry, so many skills are demanded . . . the assessment should be aligned with the skills . . . it has been an eye opener to see there are many ways to do PBL, but PBL here is really comprehensive including many factors influencing each other . . . my understanding before was quite superficial . . ."

She also expressed her changed view on the role of being a teacher. Before, she believed a good teacher was knowledgeable and cared for students, but she also thought that students should learn to learn by themselves. Now she believes:

> "Teachers are more important than students . . . how teachers are updated in one's field and connected with the real life will define how open-minded he/she can provide the classroom to the students . . ."

At this stage, she was confident that she could implement PBL with 70% of her wishes to become real. Regarding the remaining 30%, she was mostly concerned how to support students with real life projects coming from industry. After all, it would take time to build an efficient system, with industry on board, to support students' projects in her own context. If she could find a solution for that, then how to assess industry related student projects would be another challenge for the existing system.

Programme end

L also exhibited a connection between her beliefs, self-perception, goals and action possibilities, through her constant reflection on how to transfer what she had learned to her prospective teaching practices. Her action plan was not only to implement PBL in her own class but also train more colleagues to implement PBL at a larger scope in the Bioengineering programme. One cultural concern was mentioned in her action possibility thinking, how to provide fairness in grading to balance different levels of contribution in teamwork, since it will take time for students to understand real collaboration.

> "My learning about PBL is becoming deeper along the programme, it is also a way I actually learned more about what pedagogy and education are. . . The first core is about where the problem is from and who defines the problem, this really matters about how students may learn . . . the learning can be maximized if students make the efforts to do all these. . . Secondly, my belief about the teaching role is dramatically changed. . . In a PBL setting, teachers may not know the answers, and no one can predict the solutions until the projects are done. . . There may not be absolute correctness. . . This is so different from other ways of teaching. . . In a truly student-centred learning environment, the teacher does not have to say a lot, but rather design activities to let students do things . . . then the role of assessment is so crucial . . . in China we use assessment to control the so-called quality, but at the end students just memorize to learn and then they forget after exams . . . in a PBL setting, you assess the competences which are more important. . . I will have a lot to do to change my practices after my return. . .

Summary: Overall L demonstrated a harmony of role identity change and growth, integrating all four dimensions. In particular, her change of belief and goals are closely associated. Questions surrounding the definition of real student-centred learning, the role of knowledge, teamwork and authentic and meaningful learning contexts further shifted her beliefs in the direction of constructivist understandings of learning and thereby, also resolved previous tension between her beliefs and goals as a teacher.

Her self-perception as a highly motivated and passionate teacher meant that she was focused, with clear goals and open to change from the beginning of the programme to the end, with little concern in relation to her perceived action possibilities of realising and implementing what she had learned as a future change agent.

L had knowledge about and interest in pedagogy and PBL prior to participating in the programme and she had a clear aim to gain more knowledge in order to take it home. As such, PBL did not seem foreign to her, and she did not relate the PBL practices that she studied to local or national culture. Rather, from the programme beginning she identified herself as part of a (universal) teacher community about teaching and learning in HE and sharing practices and identity with the facilitators of the programme. Thus, the intercultural context played a lesser role of enabling or constraining her change and there was little to no alienation of 'others'. She did mention a concern of fairness in grading group-based projects, which she characterised as a cultural concern and challenge in China. However, this could be related to a more general debate on assessment culture in higher education, focusing on individual processes and performances.

Participant Z

Background

Having a background in Material Processing, participant Z teaches courses in Non-destructive Testing. According to him, his department is not doing well in pedagogical practices and research and their students lack intrinsic motivation in learning. In his own teaching, he felt confident in presenting knowledge about theories and "practical examples" to motivate his students, since he had working experience from a factory. However, he felt that he lacked both "frontier knowledge" of the field and enough knowledge about teaching methods to motivate the students to learn. All of these had made him choose to participate in the PBL training programme.

He believed that the students should not only have good skills to meet the needs of society, but also have "stronger spirit of innovation, sound personality and correct emotional attitudes and values". Therefore, as he wrote in the portfolio, "a 'good' university teacher should tell students why to learn, how to learn and help the students to build the right values." In everyday teaching, the teachers should combine theory with practice by presenting cases/examples on how to solve "practical problems" and deliver the knowledge matching students' interests, and the needs of their future employment and lifelong learning.

Besides learning about teaching methods, participant Z had a goal of writing and publishing academic papers on PBL during his stay in Denmark. Therefore, he hoped to learn about "how to write papers on PBL, including publications, paper framework, and writing skills, etc.", which was beyond the scope of the training programme.

Programme Midterm

With the goal of learning about PBL and producing publications, Z engaged himself in learning basic theories on PBL and the Danish education system. He highlighted visiting local schools as a good complementary way of learning about the Danish education system. As he recalled in the interview, he learned about the "entire Danish education system" by listening to a lecture in the beginning of the programme, which did not give him a clear understanding. He realised that he learned much more about "the teaching objectives, evaluation, student performance and education conditions" through a visit to a school. He valued the way of learning by experiencing and doing, not just presenting cases from real life in a lecture.

Z also reflected that group work is a good way of developing communication skills and a motivating way for learning about the similarities between traditional Chinese philosophies and PBL, and the use of group work in China:

> "Many concepts, including PBL, had been mentioned by our ancestors in China. (For instance,) Wang Yang Ming's theory of unity of knowledge and action. In fact, we have similar concepts. But because of different objective factors, our current education system is limited to do much about it. I think we have not paid enough attention to the team spirit."

After realising that the Chinese education system and he himself might have neglected the use of group work in teaching and learning, Z further reflected on the possible reasons: the general focus on individual assessment and "fewer hours for specialized courses, insufficient hours for practical courses and insufficient ability for students to solve practical problems."

The consideration on action possibilities came along with his reflections on learning. As Z wrote in his portfolio, he planned to use PBL in some of his courses upon return to China, by "applying for the school's support, improving teaching methods, attaching importance to group work, connecting theory and practice, improving students' learning motivation and their ability to solve practical problems." At this stage, his plan on how to use PBL in his teaching was not concrete.

Z could perceive his own improvements in communication skills, understanding of teaching methods, understanding of Danish culture and the English language. However, he was not very satis-

fied with the learning outcome regarding teaching methods. As he explained in the mid-term interview,

> "my overall concept of teaching method is not holistic. I have learned some knowledge, But I feel it is incomplete, (my understanding of) the system is incomplete. If I want to summarise it and see what I have learned, I always feel that something is missing."

When he said, "summarise it", he meant writing an academic paper on PBL. Therefore, the dissatisfaction was connected to his other goal (producing academic papers) for participating in the programme. To reach the goal on publication, he planned to continually read literature and improve his English language skills.

Programme End

In general, Z also demonstrated a harmony of role identity change and growth, integrating all of the four dimensions. In the end of the programme, Z repeated his belief in group work as an important social learning model.

Z also reflected on his belief change on the role as a university teacher and on teaching and learning. As he wrote, he believed that the teacher is not only the provider of knowledge as he thought, but also

> ". . . the sharer of students' learning passion and success joy, and the learner who makes progress together with students. The role of teachers is to guide the process, not to lead the process of development; monitoring quality, not interfering with processes; it is the teacher's job to make suggestions and evaluations."

He now believed that students are the core of learning.

> "Teachers and students communicate with each other, enlighten and complement each other. In this process, teachers and students share thinking, experience and knowledge, exchange emotion, experience and idea, enrich the teaching content, seek the new discovery, so as to reach the consensus, share, advance together, realising teaching and learning and common development."

At this stage, his considerations on action possibilities became clearer and concrete. As he wrote and said, it was a must for him to modify the form or elements of the PBL model to match the characteristics of the Chinese education system and his courses, because of the differences between Denmark and China. As "the motivation for students to learn and the challenge for them to start their learning process", the 'problem' in PBL, together with group work, will be the essential parts of his reform. Z was confident on using what he had learned and improved in this programme for the course reform in China. However, he also admitted that new challenges might follow the actions.

Summary: Participant Z's story shows a significant change in his teacher role identity system during the course of the programme. To begin with, Z had an obviously teacher-oriented approach, based on an understanding of the teacher role as being all-knowing, delivering knowledge through primarily lecturing and a self-perception as a researcher. At the programme-end he had changed his beliefs about the teacher role to be a more student-centred and co-creative process between teacher and student. He still perceived himself as a researcher primarily but, at the same time, he also set goals of improving student motivation and their ability to solve problems through the implementation of PBL. This partial change in self-perception caused some tension in Z's teacher role identity system and, in the end, he also exhibited change agentic behaviour, related to a teacher role identity. He did have some concerns related to his perceived action possibilities, in relation to the characteristics of Chinese education. While recognizing the richness of Chinese culture historically, he also saw the limitations in the present, affecting his perceived possibilities.

5. Discussion

Regarding the first research question on how change can be identified in teacher learning, the DSMRI model integrates understandings from multiple perspectives on identity and motivation. By using the DSMRI we capture the rich, complex, dynamic, and contextualised nature of teacher identity, while anchoring it in established identity and motivational constructs. The model highlights the central roles of knowledge and emotion in teacher identity and motivation; emphasises the interdependence of identity elements and, hence, the irreducibility of the teacher identity to its components. This illustrates the continuous emergence of identity content, structure, and process of formation and portrays the non-linear and non-deterministic nature of identity change as afforded and constrained by cultural means, as well as individual, dispositional characteristics. All three engineering teachers demonstrated their change of role identity through learning in the PBL programme in all four dimensions of the DSMRI model. Their path to change also revealed similarities and differences. Results of the study suggested that the participants' role identities and experiences prior to the programme impacted their first stage of learning and change. Participant L demonstrated her readiness to learn from the programme with regard to all four dimensions of the role identity: holding student-centred learning beliefs, having a clear goal of learning PBL pedagogy and, by

perceiving herself as a legitimate peripheral participant of the programme in the roles of teacher and change agent. Participants C and Z did not have clear goals as to what to expect from such a learning programme and they mainly perceived themselves as engineering teachers, believing their main roles were to deliver subject content knowledge, without foreseeable action possibilities.

In the later part of the programme, L's growth was progressively developing in all dimensions of her role identity, highlighting becoming a change agent, C demonstrated a dramatic growth of change in his beliefs, goals and self-perceptions, although his action possibilities were still unclear and limited, highlighting a good intention without clearly stated plans causing some tension. Z still perceived himself mainly as an engineering researcher rather than an educator, by stressing his goal to do more research through international collaboration, but also saw changes in beliefs and goals.

Thus, it is important for engineering educators to have awareness of their own individual needs, motivation sources, learning methods, and their own prior experiences to manage their own learning. On the relational level, peer support through teamwork and interpersonal relationships is also a helpful source for individual engineering teachers to become self-organised and empowered and to take agentic actions. Establishing a community of practice may further support professional growth and management of the further negotiation of teacher role identity, through engaging and changing teaching practices [7, 11, 15].

To address the second research question, concerning belief about cultural community and identity as enabling and/or constraining learning and change process, the findings of the study suggested a few factors that served both as resources and constraints for learning, which provides practical implications for professional learning programme practices. At the individual level, the variation of the participants' role identity change process suggested that each engineering teacher navigated their professional learning in a personally different way. For instance, various sources and factors influenced their intrapersonal values including beliefs, goals and self-perceptions giving them different dispositions in terms of framing their experiences. The DSMRI model does not offer a specific definition of culture in the model. It is based on a broader understanding of socio-cultural contexts that 'frame and influence' the identity system, similar to the way the behaviour of water is influenced by pressure and temperature [30, p. 13]. Hannerz [42] problematised the uncritical use, following loose definitions, of the term *culture* within research, and public discourse in general, for not specifying precisely enough what the term actually covers as it could be everything and thereby also nothing. This could also be said about the DSMRI model. This study has taken an open meta approach to culture, having the way participants conceptualise culture and 'otherness' as a central part in analysing how beliefs about cultural community act as a possible catalyst or constraint in interculturally situated, professional learning programmes. Research within the field of interculturality has described xenophilism and exoticization of the 'other' as mainly problematic in terms of racism and culturalism but, for participant C, the conceptualisation of the 'other' as essentially different and global discourses [19] of the superior West seem to lend credence to the learning experience and act as a starting point for change. In contrast, for participant Z, a more static and essentialist understanding of Chinese students and educational culture is experienced as a constraint in relation to his perceived action possibilities. For participant L sharing community and identity with the teachers and the programme content, meant she did not experience the PBL-practices as foreign despite the international context. Thus, the different conceptualisations observed, the uses and outcomes of cultural beliefs and resources in the studied complex dynamic system underline the complexity and unpredictability of the role of culture in such programmes.

Third, at an institutional level, these individually constructed learning processes through role identity change may impact the complex system of a professional learning programme (in particular) and engineering education (in general). A clearer understanding of engineering teachers' individual complex dynamic systems of learning may help explain the process of intricate interactions occurring in a PBL programme, providing implications on how to further redesign the programme to better facilitate the teacher professional learning. The findings of this study also raised the need to further longitudinal support to the actual change in their practices of implementing PBL [16, 17]. There is a particularly strong need for institutional support at policy level to promote the autonomy of engineering teachers to become change agents and pedagogical leaders and better support their agency towards accomplishing their goals as change agents in education [6, 9, 22]. Last but not least, culture has played an important role for teaching and learning in this study, both serving as a trigger for learning and a constraint for developing action possibility by the participants regarding how PBL can be implemented in reality. This finding indicates that the future intercultural professional learning programme may include discussions and reflections

regarding how to better use cultural beliefs and resources as a tool to empower both learning regarding change of beliefs and goals, and enlarging possibilities of actions for change in practice. As such, a greater awareness of culture as a context and source of change and constraint in relation to learning could be incorporated in the programme by encouraging participants to explore and reflect on the role of culture.

The study has a few limitations. Firstly, focusing on subjectivity, although the use of a qualitative case study, integrating progressive written reflection and narrative data with a life history angle, offered us opportunities to provide in-depth insights of how engineering teachers develop their learning through change of role identity in a study abroad programme, the small size of the participant population did not support generalisability and transferability. There may have been other, different stories by other participants in the programme that may potentially give other accounts of change and learning. Second, due to the debate on how case study data, in particular, and sources of narrative inquiry can be analysed, we combined both approaches by providing individual profiles in the forms of stories and then discussing the stories through comparison and in relation to the complexity theory and the model of complex dynamic system of role identity. By doing so, we have hoped to provide space for readers to develop their own interpretations. Nevertheless, there may be aspects we have missed or there may be different findings from having conducted the analysis differently [37]. Therefore, future studies may include more participants to provide a bigger variation of paths to change in teacher professional learning.

6. Conclusion

In this paper, we reported stories of three Chinese engineering teachers' professional learning, focusing on role identity change in a 6-months-long PBL programme in Denmark. The three stories revealed that teacher professional learning is situated in a complex system, consisting of many interactive elements of intrapersonal, relational, and environmental aspects. Rather than learning from receiving information as expected in many pedagogical training programmes, the three participants' learning and change processes were non-linear and dynamic with emerging instances, which was also a process in which they renegotiated their teacher role identity. The features of PBL, such as inquiry-based, organisation in teams, and work on real world problems for creating meaningful contexts for learning, all supported these processes. Through the lens of complexity theory and using the dynamic systems model of role identity as an analytical tool, the study provides insights into how teacher learning took place in an intercultural professional learning environment, future studies may develop other empirical methods for data generation, to examine progressive change. In particular longitudinal perspectives focusing on participants' change in their actual teaching practices shall also be explored in order to provide further insights of the complexity system of teacher learning from the study-abroad professional learning programmes. We also see a potential of the methodological approach to be transferred to other contexts e.g., student sojourns abroad examining students' role identity and change as global intercultural citizens or other professional learning programmes adopting other pedagogical designs than PBL.

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