*International Journal of Engineering Education* Vol. 37, No. 4, pp. 900–914, 2021
Printed in Great Britain

0949-149X/91 $3.00+0.00


# Academic Staff's Motivation, Outcomes and Challenges in a Pedagogical Training Programme of PBL*

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PBL (Project-based/Problem-based Learning), as a core method of student-centred learning, has become a widespread teaching and learning methodology in higher education during the past 30 years because of its effectiveness in improving students' academic knowledge, teamwork skills, communication skills and leadership. However, the educational reform using PBL methods is a long-term task and also a challenge for engineering staff. In order to improve the PBL implementation, it is important to provide PBL pedagogical training opportunities for engineering staff. Taking an international pedagogical training programme as a case, this study illustrates academic staff's learning motivation, experience, outcomes and challenges in a pedagogical PBL training programme. Suggestions are proposed to optimise the design of pedagogical training programmes for engineering staff professional development to promote effective curriculum change processes.

**Keywords:** PBL; staff training and development; challenges; curriculum change

## 1. Introduction

Curriculum change and development in higher education is difficult for two reasons: firstly, pedagogical training has not been a tradition at the universities and only in a few universities is pedagogical training part of the tenure track, otherwise most pedagogical training was accessed through research and research projects that staff introduced [1, 2]. Secondly, faculty members normally teach as they have been taught, as they do not have any other experiences and are more focused on the content than the learning [3]. Therefore, training of new educational practices is a necessary element in any change process.

In particular, problem- and project-based learning (PBL) will require pedagogical training for faculties if an institution aims to change from traditional learning to more student-centred learning methods. PBL has become a widespread teaching and learning methodology in higher education during the past 30 years, with various models ranging from problem-oriented to project-oriented, from the single course level to the systematic curriculum level [4]. In most cases, problem-oriented PBL provides a learning context for students to identify and solve open-ended and ill-structured problems, while project-oriented PBL is interpreted with an assignment or task requiring students' performance. In spite of the diversity of PBL, the various practices are based on the same types of learning principles: changing from teacher-centred learning to student-centred learning. This change is one of the responses from higher education to meet the requirement for new competences of twenty-first-century talents, such as employability and complexity according to UN Sustainable Development Goals. Prior research pointed out that the application of PBL equipped students with employability skills, including collaboration, business understanding, problem solving and so on [5].

However, the educational reform with PBL methods is a long-term task and often lacks sustainability when changes to PBL only occur at the single courses' level instead of the institutional level [6]. In a PBL environment, both students and engineering staff were found facing difficulty of transferring learning/teaching practices from traditional methods to PBL strategies, such as lacking PBL theoretical knowledge, facilitation skills, and effective assessment methods [7–9]. Considering the diversity of PBL methods, engineering staff need to overcome specific challenges when implementing differ-

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* Accepted 15 January 2021.

ent PBL strategies. In problem-based learning, they need to identify the difficulty level of problems and learn skills to balance between helping with and influencing students' problem defining process [4, 8]. In project-based learning, as facilitators for project and teamwork process, engineering staff might experience heavy workload and need practical experience in one or multidisciplinary fields [7, 9]. Moreover, another issue in change processes is that many pedagogical trainings are mostly theoretical and aimed at faculty members' development of beliefs in teaching, which miss out reflection on the implementation of new practices in respect of both intended and implemented practice [10]. In addition to teachers' beliefs in teaching, the combination of practicing problem-oriented and project-oriented PBL at different levels is also a significant component of the design of new educational practices [11].

Thus, PBL pedagogical training with an exemplary way for possible implementation are needed for engineering staff. The training should promote a community of new practices and a culture of ongoing organizational reflection and learning [12–14]. With these aims, the Aalborg UNESCO Centre at Aalborg University (AAU, Denmark) has a long-term collaboration with the North-eastern University (NEU, China) and set up a half-year certificate programme every year since 2018, which focuses on the basics of PBL and curriculum change for engineering staff development.

Based on six-month training programmes held every year, this study aims to provide a deeper understanding of how pedagogical training programmes influence teachers' professional development and how engineering staff co-construct a possible design of on-going educational changes in their institution through PBL pedagogical training programmes.

The research questions for this study are: (1) What motivated engineering staff to join the PBL pedagogical training and curriculum changes?; (2) What did engineering staff gain from the PBL pedagogical training programme?; (3) What challenges did participants face in PBL pedagogical training programmes? Applying a qualitative method, this research reports teachers' motivation, reflections, learning outcomes and challenges through the PBL training programmes.

## 2. Literature Review

University faculty members have an obligation to train talents with professional knowledge and skills, comprehensive competences and employability to meet the needs of society, which proposes new requirement for high-quality education [15]. Corresponding with these new learning tasks, staff development and pedagogical training is essential. In order to expose engineering staff to educational innovations, their motivation and beliefs in professional development and curriculum changing is addressed in many articles [16, 17]. Problems in teaching experience, wishes to improve teaching quality and students' learning, needs for redesigning the course or curriculum, were reported to motivate academic staff to join pedagogical training activities [18] (Ballantyne et al., 2010). For those who are inspired to acquire new educational knowledge and teaching/learning methods, pedagogical training activities could have higher effectiveness in promoting possible changes in educational implementation [16, 19]. However, teachers could meet difficulties in adjusting their self-identification, changing teaching/learning strategies, organizing activities and so on [20]. To help them overcome those challenges and improve their instruction abilities, many universities have arranged diverse pedagogical training activities, such as instructional development workshops, exchange opportunities for staff development, and seminars of educational skills and online courses for teaching/learning [21]. Specifically, more digital support and online training programmes for academic staff are optimized to provide them with diverse pedagogical resources [22, 23].

With various practices of teachers' pedagogical training, previous research focused on the assessment of the effectiveness of staff training programmes. Guskey (2000) proposed a model with five levels to assess the impact of staff development programmes: teachers' reactions; teachers' learning; organization support and change; teachers' use of new knowledge; and students' learning outcomes in changed practices [24]. However, it was also pointed out the difficulties to tell the full story of actual changes in students' learning outcomes as a result of faculty pedagogical training [25]. Based on this model, many studies evaluated the effectiveness of staff training activities by exploring teachers' conceptualization of professional development, understanding of learning methods, setting instructional objectives and using active learning in their courses through interview, observation and survey after training activities [26–28].

Meanwhile, challenges in staff training were also reported. One issue was that attendance for those activities was sometimes low because of complicated reasons, such as lower levels of motivation, time limitation, heavy research workload, and unawareness of the necessity for quality learning/teaching etc. [12, 29]. In particular, in the field of engineering education, engineering staff saw themselves as experts in specific engineering fields and

less as pedagogues or trainers for future engineers, which led to lower interest in developing pedagogical skills, and therefore they are less prompt to engage in pedagogical training activities [21]. For other staff, they realized the importance of effective learning methods and accumulated skills and reflection based on their own practices, but there were few pathways to link pedagogical theories with their own experience [30]. Although some of them joined related pedagogical activities, difficulties were reported with high frequency, including too many theories, insufficient attendance in those activities, lack of feasibility and less help on teaching/learning practices [12].

To deal with reported challenges, efforts are needed not only from individual teachers, but also from the institutional level [4]. For effective staff pedagogical training, researchers emphasized the necessity for a systematic professional development design from educational institutions, which should follow the principles of sufficiency, advanced training, consistency, continuity and a multi-tier system for teachers with different pedagogical knowledge and skills [17]. Without providing teachers with exemplary ways for possible implementation and a systematic training design with sustainability and consistency, the attraction of pedagogical training could be limited and the efficiency of those programmes on educational change progress could be influenced negatively [12, 13]. Specifically, when it comes to staff pedagogical training on PBL, teachers are supposed to take the role of facilitators rather than lecturers, but specific issues are faced by them, such as identifying the difficulty level of problems for students to solve, designing learning activities, choosing effective assessment methods, dealing with a heavy workload as facilitators and that is a new practice that has to be learned [6, 31, 32]. Due to the unfamiliarity with PBL pedagogy, teachers need more instructions on how to facilitate students in teamwork and inspire their self-directed learning in an effective way [33]. Thus, it's important to provide teachers a simulation to take the role of students and experience new teaching/learning methods in an exemplary way [34]. More experiential staff pedagogical training programmes with systematic design and institutional support are needed, especially for PBL.

Prior studies reported PBL training programme design, tool development for teachers' use in PBL courses, and evaluation of PBL training activities [35–38]. In Denmark, with the national and institutional strategies for staff development, a series of training activities on PBL methods were conducted, such as PBL training workshops, conferences, online courses and an online part-time master programme in PBL training for engineering staff [35, 36]. Through experiencing PBL as students, academic staff could develop a systematic understanding of pedagogical knowledge and PBL methods, which could smooth the processes of transferring their roles from lecturers to facilitators in PBL practices [36]. Based on an evaluation of online PBL training, Brodie and Jolly (2012) also pointed out that teachers' facilitation skills were improved through group discussion and self-reflection in PBL training activities [38]. However, although several studies pointed out PBL training is helpful for faculty development, with limited studies on staff PBL training, it's still unclear about what motivate teachers to learn PBL methods, and in which ways PBL training activities contribute to teachers' professional development and educational changes. Thus, this study explored engineering staff's motivation, learning outcomes and challenges in the PBL training programmes, using a qualitative method.

## 3. Methodology

### *3.1 Context and Sampling*

The Aalborg UNESCO Centre at Aalborg University (AAU, Denmark) has set up a staff professional development system with a variety of educational and staff training activities. The current staff training system includes three learning levels: know what; know how; and know to be (Fig. 1). The first level – know what – provides basic knowledge regarding PBL and takes a more transmissive approach. The subsequent levels, 'know how' and 'know to be', become progressively more participant-directed and problem-oriented, moving from hands-on activities and workshops towards a collaborative research-based project for change [13].

In the spring of 2018, the Aalborg UNESCO Centre set up a half-year certificate programme (equivalent to 10 ECTS) with the collaboration with the North-eastern University (NEU, China). Along with the recent higher education reform supported by the national government, NEU is trying to change from a traditional teacher-led education model to an innovation model with a core principle of student-centred learning. With this objective, the cooperative programme is on the Basics of PBL and Curriculum Change for engineering staff development, which aims to train participants in PBL skills and to contribute to the change of practice. Participants are expected to obtain PBL theoretical knowledge, improve their facilitation skills, and develop an initial PBL design for a course or an institution.

In the alignment with training objectives, the training programme is composed by four modules (Introduction and preparation, thematic work-

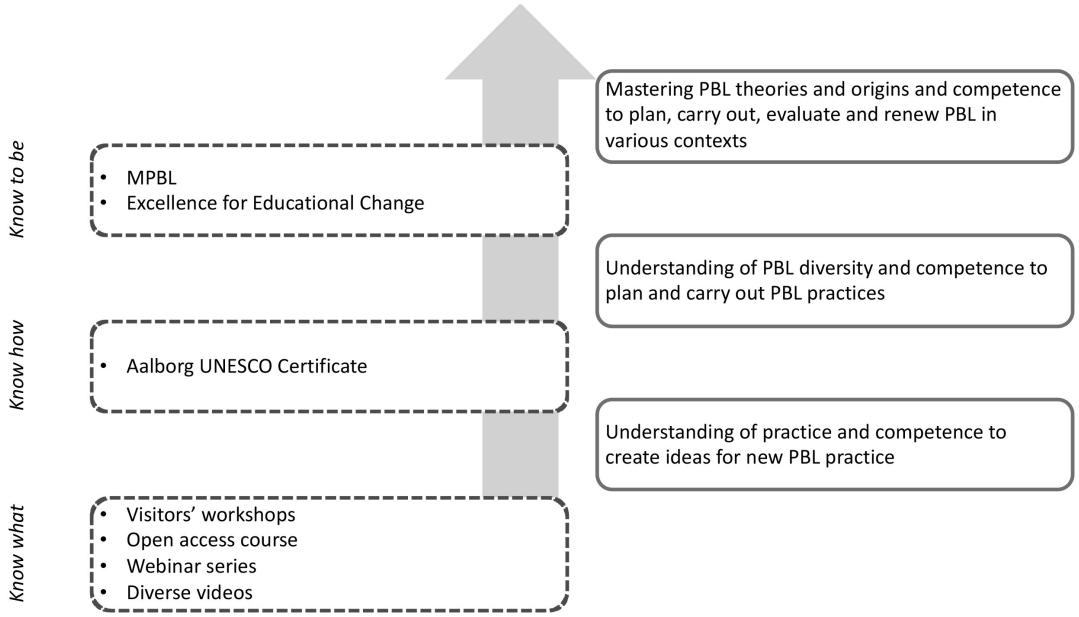


**Fig. 1.** Overview of Aalborg UNESCO Centre activities for academic staff and different levels of development of PBL knowledge and competences [13].

shops, experimentation and evaluation, examination), in which diverse learning activities are arranged for participants, including group work, workshops, seminars, supervision meetings and examination. Specifically, workshops with the topics of PBL development history, PBL principles, diverse problem-based and project-based learning models, facilitation skills, teamwork skills, assessment in PBL etc, were designed for participants. In group work, participants are required to do problem analysis and formation, understand and apply PBL theories, conduct empirical work, choose the PBL methods for their future PBL practice and report their design. Learning resources and materials (literature, slides, online courses and videos, etc.) are provided through the online Moodle platform for all participants. Moreover, learning portfolio are used in learning processes, in order to help participants record their ongoing work and challenges, promote their reflection and inspire their group discussion. Since the autumn of 2018, a small group of engineering staff from different STEM subjects (with 7–8 members) have come to Denmark and started their half-year training programme every year. Up to the spring of 2020, two groups of staff have finished their pedagogy and PBL training programmes and begun their PBL practices for education changes in their institutions.

In this study, we sent interview invitations via emails to all participants from two PBL training programmes in 2018 and 2019, which separately had seven and eight participants in total. Among all

**Table 1.** The basic information of participants

| Name | Programme | Subjects | Gender | Years of Teaching | Position |
|---|---|---|---|---|---|
| Albert | 2018 | Robot design and engineering | Male | 13 | The leader of undergraduate teaching |
| Freda | 2018 | Metallurgical engineering | Female | 14 | Associate professor |
| Andrew | 2018 | Software engineering | Male | 11 | Lecturer |
| Bella | 2018 | Materials engineering | Female | 6 | Associate professor |
| Daniel | 2018 | Business administration | Male | 24 | Dean |
| Edward | 2018 | Computer engineering | Male | 16 | Associate professor |
| Henry | 2019 | Energy engineering | Male | 8 | Lecturer |
| Carl | 2019 | Computer engineering | Male | 8 | Associate professor |
| Dora | 2019 | Mechanical engineering | Female | 22 | Associate professor |
| Joy | 2019 | Business administration | Female | 34 | Dean |
| Ivy | 2019 | Physics | Female | 13 | Associate professor |
| Bill | 2019 | Software engineering | Male | 6 | Associate professor |
| John | 2019 | Mechanical engineering | Male | 5 | Lecturer |

invitations, six teachers from the 2018 programme and seven teachers from the 2019 programme responded to our invitations for interview, thus a total of 13 engineering staff from two PBL training programmes were recruited (Table 1). For the sake of privacy protection, pseudonyms are used for all interviewees.

### *3.2 Data Collection Procedure*

A qualitative thematic interview method was utilized to investigate engineering staff development in PBL training programmes, which enables researchers to hear individuals' voices and explore their common experiences [39]. We focused on individuals' reflection on their learning experience and learning outcomes through PBL training. Data are mainly collected via 30–45 mins semi-structured individual interviews, conducted at the end of the programmes to enable participants to reflect on their full range of project works. Based on prior studies on staff development in PBL training, the interview protocol was designed, tested and revised for three rounds through pilot interviews and group discussion with two experienced experts in PBL research and qualitative methods. Sample questions of the interview guidance are shown in Table 2.

### *3.3 Data Analysis*

All interviews were transcribed and confronted two more times. The initial codebook was firstly built upon the analysis of three information-rich transcripts, which constitutes a relatively stable frame for coding [40]. Three categories – motivation, learning outcomes and challenges – were defined as priori codes. Then open-coding and thematic analysis methods were used to identify both a priori codes and bottom-up codes. In the coding process, the researcher remained open to new codes as the data unfolded themselves. All codes were classified into the three categories of motivation, learning outcomes and challenges. A comparison between groups from the 2018 programme and 2019 programme was also conducted to explore the general longitudinal development of NEU staff in PBL training and possible improvement of the design of the following year's training programme.

In qualitative studies, as the 'primary instrument for data collection and data analysis', researchers should be aware of their responsibilities of valid research and be adaptive in these processes [41]. In this research, the researcher with prior PBL experience and basic pedagogical knowledge was involved in daily journaling and self-monitoring in data collection and analyses, in order to be aware of any potential bias and influences from prior experiences. Codes were modified through group discussion, conducted with the facilitator of participants' groups and two experts in PBL research and staff training, who also gave workshops to all participants. Moreover, an external graduate student majoring in higher education and experienced in qualitative research was invited to code one information-rich transcript and compare results with the lead coder. At the priori code level, the external coder reached an agreement of 93.7% with the lead coder. Resulting in 81.4% at the sub-code level, a revised codebook was formed through discussion and revision in the auditing process and then used for the whole data analysis processes.

## 4. Findings

### *4.1 Motivation and Expectation*

Based on qualitative data, participants' motivation to join the PBL training programme included multiple expectations of curriculum change in their institution, optimization of their own courses, pedagogical knowledge acquisition and skills development (Table 3). The number of participants refers to how many participants mentioned this code in the interview. At the curriculum level, six participants reported their expectations of curriculum change with PBL methods in their institutions. Two of

**Table 2.** Sample questions of the interview guidance

| **Descriptive questions** |
|---|
| Can you describe your daily activities in this programme briefly? |
| **Questions in the aspect of motivation** |
| What factors influenced your decision to participate in this programme?<br>What do you want to achieve, personally and professionally with this programme? |
| **Questions in the aspect of learning experience and outcomes** |
| What were the most significant/surprising experiences you had in this programme?<br>What do you think you got out of your experience in the PBL training?<br>What skills have you developed from your experience in this programme?<br>How do those learning activities affect your values and interests? |
| **Questions in the aspect of challenges** |
| What challenges have you encountered during the learning processes?<br>What was most challenging in teamwork? How did teamwork influence your learning in this programme? |

**Table 3.** Codes regarding participants' motivation

| Themes | Codes | Number of Participants (2018) | Number of Participants (2019) |
|---|---|---|---|
| **Curriculum Change** | Learn advanced learning methods in undergraduate programmes | 3 | 4 |
| | Take the task of educational change as a department leader | 1 | 1 |
| | Learn how to link university education with industry practices | 1 | 1 |
| | Learn how to develop students' comprehensive competences | 1 | 1 |
| **Course Optimization** | Improve students' learning outcomes | 4 | 4 |
| | Improve their course design | 4 | 4 |
| | Feel unsatisfied with current teaching practices | 3 | 4 |
| | Learn how to inspire students' active learning | 2 | 2 |
| **Knowledge Acquisition** | Learn more pedagogical theories and PBL methods | 5 | 6 |
| | Know more about other institutions' educational practices | 3 | 4 |
| **Skills Development** | Improve their teaching/instructing skills | 4 | 6 |
| | Learn how to develop one's critical thinking | 1 | 1 |
| **Individual Aspiration** | Be encouraged by previous participants | 0 | 3 |
| | Experience foreign culture and lifestyle | 1 | 2 |
| | Have a period of time for reflection | 1 | 1 |
| | Experience teamwork processes | 0 | 1 |

them took the position of leader in the aspect of teaching and learning in their departments, thus they thought themselves with more responsibility to promote the curriculum change and implementation of PBL.

Most teachers focused on improving their own courses through the PBL training since, as lecturers, they had limited power to promote the challenging and long-term changing process. They believed PBL training programmes could bring them instructing skills and pedagogical knowledge. Therefore, they could improve their current course design and practice for students' better learning outcomes. In Edward's case (2018 group), he was unsatisfied with his current teaching practice and eager to find instructions to help him inspire students' active learning:

> "I read an article about PBL and became interested in this method. But I'm not an expert in this field, and a few articles cannot provide an overview of PBL methods. I need a systematic learning of effective practical methods, like PBL, to guide me to optimize the course design and improve the quality of learning, so I applied for this programme as soon as I heard about it."

Three participants from the 2019 group were encouraged to apply for this programme by participants in the 2018 group. When participants in the 2018 group went back to China, they held workshops and communicated with their colleagues to introduce PBL methods and share their experiences, inspiring some colleagues' interest and curiosity in PBL. Just as Carl (2019) described:

> "Edward is my colleague and friend. When he came back from AAU, he told me a lot about PBL, and he tried to promote PBL in our department. I agree PBL is effective for undergraduate education, but I know so little about this method. I need to come here and experience PBL by myself."

In Carl's case, he was encouraged to join the next PBL training programme by his colleague Edward, who participated in the 2018 PBL training programme. Developing new interests in learning and applying PBL methods, he decided to join the learning programme in 2019.

### *4.2 Learning Outcomes*

Participants' learning outcomes through the pedagogical training programmes ranged from the improvement of knowledge and skills to changes of perspectives and interests. Comparison between two groups was also conducted and is presented in this study.

#### *4.2.1 Knowledge*

In terms of knowledge acquisition, we identified 14 codes, as shown in Table 4. Frequency is related to how many times the code is found in transcripts. Participants reported that they obtained pedagogy knowledge, such as 'systematic pedagogical theories', 'alignment of PBL curriculum design', 'PBL principles and methods', and 'benefits of PBL for students' etc. Tools on choosing suitable topics/problems for students, inspiring students' active learning and smoothing their teamwork processes were also provided for participants, which enhanced their awareness of possible learning strategies in different situations. Moreover, they experienced different campus culture and national

**Table 4.** Codes regarding knowledge in the dimension of learning outcomes

| Codes | Frequency (2018) | Number of Participants (2018) | Frequency (2019) | Number of Participants (2019) |
|---|---|---|---|---|
| Systematic pedagogical theories | 16 | 5 | 16 | 6 |
| Possible strategies to apply PBL | 16 | 6 | 19 | 7 |
| Alignment of PBL curriculum design | 15 | 4 | 18 | 6 |
| Different campus culture and national culture | 13 | 5 | 21 | 7 |
| PBL principles and methods | 13 | 5 | 18 | 7 |
| Challenges faced by students in PBL | 7 | 4 | 2 | 1 |
| Challenges faced by students in teamwork | 6 | 2 | 3 | 2 |
| Different academic paradigms across disciplines | 6 | 3 | 8 | 3 |
| Diverse educational practices across universities | 6 | 3 | 6 | 2 |
| PBL history | 5 | 2 | 6 | 2 |
| Assessment methods in PBL | 5 | 2 | 2 | 1 |
| Tools for active learning and discussion | 5 | 4 | 6 | 3 |
| Benefits of PBL for students | 4 | 2 | 4 | 2 |
| Tips for choosing topics/problems for students | 2 | 1 | 0 | 0 |

culture, and learnt more about diverse educational practices in other higher educational institutions.

#### *4.2.1.1 Knowledge of pedagogy and PBL*

Codes regarding pedagogy theories and PBL knowledge were reported with the highest frequency in the dimension of knowledge among both groups, including pedagogical theories, PBL principles and methodology, assessment methods in PBL and various PBL implementations in other higher educational institutions. As experts in specific STEM fields, most of the participants were unfamiliar with pedagogical knowledge beforehand. At the beginning of the programme, workshops were set up to introduce basic pedagogical theories, PBL principles, and different implementations of PBL. Via those workshops, participants experienced different paradigms between education and their subjects, and began to build their pedagogical knowledge systems. As reported in John's (2019 group) interview:

> ''What I knew before was small pieces of education, mainly based on my teaching experiences. The training provides me with a big picture of the whole educational system. I know more about the alignment of curriculum design, which means that learning objectives, principles, learning activities, and assessment methods should be coherent with each other. I think these are the most important things I learned.''

Although participants might not develop their own PBL design immediately after those workshops, the pedagogical knowledge provided them the fundamentals for self-reflection on teaching practices and design for future PBL implementation. By introducing diverse PBL practices between universities across the world, those workshops broaden their horizons and inspire their thinking on how to combine characters of their subjects with those examples and transfer the successful PBL implementation into their PBL design.

#### *4.2.1.2 Diverse campus culture and national culture*

Diverse culture was also reported with high frequency, especially the impressive campus culture of collaborative learning in Denmark. According to participants, in their home university as well as most universities in China, students tend to follow teachers' instructions instead of self-directed learning and exploring. For most of students, learning is an individual process, and they lack the experience to work as real teams. However, when those teachers came to Denmark, they were impressed by the collaborative culture among Danish students. As Ivy (2019 group) reported:

> ''I was surprised by the atmosphere of collaboration among Danish students. Every group has their group space, and they motivate themselves to learn together and discuss with each other, even on Saturday and Sunday. That's truly student-centred and self-directed learning. So, I begin to think how we can motivate our students to have a collaborative spirit and take more initiative in learning instead of just following teachers' instructions.''

Through experiencing different campus culture, participants saw the differences on learning habits between students in two countries, which drove them to consider the possible strategies to motivate students' interests in teamwork and self-directed learning.

### *4.2.2 Skills*

Improvement of various skills were also found as important learning outcomes in the staff training programmes (Table 5). Codes of 'instruction skills'

**Table 5.** Codes regarding skills in the dimension of learning outcomes

| Codes | Frequency (2018) | Number of Participants (2018) | Frequency (2019) | Number of Participants (2019) |
|---|---|---|---|---|
| Instruction skills | 15 | 4 | 13 | 5 |
| Facilitation skills | 13 | 5 | 12 | 4 |
| The ability to apply PBL theories in practice | 7 | 5 | 6 | 4 |
| The ability to connect own experiences with pedagogical theories | 7 | 4 | 16 | 4 |
| Communication skills | 5 | 4 | 2 | 1 |
| Teamwork skills | 1 | 1 | 4 | 2 |
| Foreign language skills | 1 | 1 | 3 | 2 |
| Logical thinking | 3 | 1 | 0 | 0 |
| Critical thinking | 2 | 2 | 0 | 0 |

and 'facilitation skills' were reported with highest frequency in two groups. Moreover, participants developed the abilities to link pedagogical and PBL theories with their teaching experiences and practice, achieving one of the learning objectives of these staff development programmes. In the programmes, participants took the role of students and experienced PBL for themselves, improving their communication skills and teamwork skills. Among all the participants, many of them had international learning experiences before coming to Denmark, but for those without related experiences, their foreign language skills were improved since all workshops, reading materials and reports were in English and they needed to adapt to this learning environment.

#### *4.2.2.1 Instruction and facilitation*

More than half of the participants reported their improvement in instruction skills, including how to catch students' attention, design attractive slides, and inspire students' thinking and discussion in their classes. In the training programmes, ten workshops with different experienced instructors were set up for participants, allowing participants to experience different instructing styles and learn from these instructors. As illustrated by the quote from Bella (2018):

> "What impressed me is the workshop about teamwork. The instructor used Lego to make us experience the importance of teamwork. It's interesting and impressive, making us learn by playing, which is a good skill to make the class more interesting and attractive."

Facilitation skills were also reported by participants to smooth students' teamwork, such as how to help students identify the core problems and project directions, deal with disagreements and improve students' project management. On the one hand, they had experienced PBL as students and were aware of possible issues in teamwork processes. Suggestions could be provided for students when participants change their roles into facilitators. On the other hand, they gain a role model of facilitators during the training processes. Every group had a facilitator and a supervisor, who are experts in staff training and PBL methods. By observing experts' behaviours, experiencing their facilitation process and discussing facilitation skills with them, participants gained the role model and improve their facilitation skills to guide students' self-directed learning.

#### *4.2.2.2 Utilization of PBL methods*

As pointed out by participants, the training programme helped them build bridges between their teaching experiences, pedagogical theories and PBL practices. After a systematic training on PBL methods, more than half of the participants reported that they could better use the theoretical knowledge to guide their future practice.

> "At the beginning, I was doubtful about functions of PBL since we had had many failures on practising active learning. However, at the end I realize those theories have greater functions on guiding our practices and those are what I can really use for future practices."

### *4.2.3 Perspectives*

The changes in participants' perspectives and interests constituted a significant part of their learning outcomes (Table 6). Participants developed changed attitudes towards learning objectives, learning processes and future PBL implementation, and their interests in teaching have been aroused.

#### *4.2.3.1 Learning processes*

Participants' opinions and values were influenced by teamwork. Half of the participants reported that they have learnt to look at things from others' perspectives and think from different angles of both educators and students. After the PBL training, they also began to reflect on their teaching practices from perspectives of learning theories. They realized that learning is not an individual

**Table 6.** Codes regarding changes in participants' perspectives and interests

| Themes | Codes | Frequency (2018) | Number of Participants (2018) | Frequency (2019) | Number of Participants (2019) |
|---|---|---|---|---|---|
| **Learning Objectives** | Realize the importance of interdisciplinary skills | 14 | 4 | 8 | 2 |
| | Realize the importance of transferable skills and competences | 13 | 4 | 14 | 3 |
| | Realize the importance of students' employability | 9 | 2 | 6 | 2 |
| | Realize the importance of setting learning objectives | 7 | 3 | 6 | 3 |
| | Realize less importance of students' grades | 1 | 1 | 1 | 1 |
| **Learning Processes** | Learn how to look at things from others' perspectives | 18 | 4 | 12 | 4 |
| | Realize the importance of teamwork | 18 | 5 | 9 | 3 |
| | Think from the perspective of learning theories | 10 | 4 | 12 | 4 |
| | Realize the importance of self-directed learning | 8 | 4 | 10 | 4 |
| | Identify the meaning of teamwork in Chinese context | 7 | 4 | 0 | 0 |
| | Realize the importance of motivation | 7 | 3 | 6 | 3 |
| | Realize learning is a co-constructed process | 3 | 1 | 1 | 1 |
| | Realize the importance of learning together with students | 2 | 1 | 0 | 0 |
| **PBL Practice** | Wish to practise PBL in their institutions | 18 | 6 | 23 | 7 |
| | Realize the difficulty of implementing PBL | 17 | 5 | 13 | 4 |
| | Change one's role from teachers to facilitators | 8 | 5 | 11 | 3 |
| | Self-reflection on one's teaching/learning practices | 7 | 3 | 18 | 5 |
| | Have support from the university | 5 | 3 | 6 | 3 |
| **Change of Interests** | Become more interested in PBL | 6 | 2 | 8 | 3 |
| | Become more interested in teaching and learning | 5 | 2 | 2 | 1 |
| | Enhance the sense of responsibility as educators | 2 | 1 | 3 | 2 |

process, but an interaction process for students to co-construct knowledge and meanings of their experiences. As reported by Andrew (2018 group):

> "The most effective way to develop our understanding of PBL is group discussion, which can provide perspectives from others. In group discussion, we review our design together and propose critical comments to improve the design. As an engineering teacher, I always emphasize the logic, but a teacher from social science provided me with a new way of thinking – the perspective of history and philosophy."

In Andrew's case, he emphasized the importance of teamwork and group discussion, where they can hear different voices from diverse perspectives. Through the exchange of opinions, participants were able to understand different paradigms and ways of thinking across subjects.

#### *4.2.3.2 Future PBL practices*

Based on learning and self-reflection, participants began to transfer themselves from the role of instructors into facilitators. They developed their understanding of PBL and came up with a detailed report, which demonstrated their plan to utilize PBL, ranging from course level, curriculum level in their major, and university level. Based on group discussion and communication with their supervisors, they reached an agreement about future implementation of PBL, and then divided up the task of report writing.

> "One of my learning outcomes is the development from knowing nothing about PBL to having an initial idea of our future PBL practice. Those theories and tools struck a chord with me, which motivates me to try something new. Now I have a plan to adopt PBL in my own course in the following semester. I can't wait to put my idea into practice."

According to Carl (2019), he expressed his interests in transferring PBL into their institutions. They proposed plans to apply PBL methods for their own courses through the training programme and had a strong passion to realize those plans.

#### *4.2.3.3 Changes of interests*

Two participants in the 2018 group and three participants in the 2019 group reported the changes in their interest in teaching and learning, especially in PBL methods. As Albert (2018 group) said:

> "I was more interested in research and didn't care so much about teaching before. But now, I realize the importance of my responsibility as educator. . . This training programme opens a window of new learning methods for me and provides me with powerful tools to

> arouse students' enthusiasm of learning. Now I hope I can do something to promote the curriculum change.''

The training experience aroused their sense of responsibility as educators, motivating them to pay more attention to educational change and the improvement of the quality of teaching and learning in their future practices.

### *4.3 Challenges*

Challenges reported by interviewees are listed in Table 7. In these programmes, teachers were required to take the role of students and finish projects in teams. On the one hand, learning as students made them face similar challenges and difficulties as students in teamwork and learning processes. As experts and instructors working for many years, those teachers perceived themselves as having richer experience in collaborative learning than students. However, during their teamwork processes, issues such as 'disagreement between members', 'how to conduct effective teamwork', and 'how to deal with free riders in groups' were also reported with high frequency, which are also faced by students in teamwork processes.

In addition to teamwork, other challenges in their learning processes were reported, including gaps between pedagogy and engineering paradigms, difficulties in transferring from traditional learning to PBL, and fear of misunderstanding the meaning of PBL. As Ivy (2019) said:

> ''At the beginning, the main challenge for me is the training is too theoretical. It's difficult for me to adapt to educational researchers' ways of thinking. Half a year might not be enough for me to fully understand those deep theories and use them as guidance for practice.''

Moreover, language barriers and differences between learning habits and campus culture also brought challenges for participants' learning. As foreigners, living and studying in an English environment was not an easy job for those participants without overseas experience. In addition, without basic pedagogical knowledge, it was challenging for them to understand the terminology in the field of education, which brought learning barriers when talking with supervisors, attending courses and workshops, reading references and writing reports, especially at the beginning of the programme.

In addition to learning as students, they also had the role of educators, pushing them to consider issues of how to implement PBL and how to deal with possible obstruction in practice. Many participants could foresee possible difficulties of curriculum changes. Although they had powerful support from their university and developed a detailed plan for PBL implementation, they still expressed their worries about the generalization of PBL in their university. As reported by Andrew (2018 group):

> ''We have proposed a curriculum design to senior managers in our university. However, how can we realize the design and promote the curriculum reform? If we adopt interdisciplinary PBL, there are too many things to consider: class size, instructional design, salary system, resource distribution, hardware facilities and so on. It's a long-term and challenging job, and we cannot be sure we will definitely succeed.''

Several participants also reported their worries about how to update their pedagogical knowledge and keep pace with the development of PBL practices in the world.

> ''What I'm concerned about is how to keep updating knowledge regarding the development of PBL theories and models. When we go back to China, we have limited time, resources and pathway to pay constant attention to cutting-edge PBL knowledge. If I meet difficulties in future PBL practice, I won't know whether someone has encountered same issues and if I have a chance to learn from others' experience.''

**Table 7.** Codes regarding participants' challenges in the training programme

| Themes | Codes | Frequency (2018) | Frequency (2019) |
|---|---|---|---|
| **Teamwork** | Disagreement between team members | 12 | 5 |
| | How to conduct effective teamwork | 7 | 9 |
| | How to deal with free riders in teamwork | 3 | 1 |
| **Learning Processes** | Gaps between pedagogy and engineering paradigm | 9 | 11 |
| | Transferring from traditional learning to PBL | 6 | 9 |
| | Not fully understanding PBL methods | 3 | 0 |
| | How to inspire self-directed learning | 1 | 4 |
| **Culture and Environment** | Different learning habits and culture between China and Denmark | 12 | 8 |
| | Language barriers | 5 | 7 |
| **Future Practices** | Difficulties of future implementation of PBL | 14 | 12 |
| | How to apply PBL at different levels | 12 | 2 |
| | Keeping pace with PBL development | 4 | 3 |
| | Adopting effective assessment methods in PBL | 1 | 2 |

As Edward (2018) said, he was concerned about the fact that, as engineering staff, they had limited resources to keep pace with the cutting-edge development of PBL. Moreover, when they try to implement PBL methods in their institution, they will meet both expected and unexpected challenges, which might require constructive suggestions from experienced experts in PBL and education.

### *4.4 Comparison between two groups*

#### *4.4.1 Implementation of PBL at different levels*

In terms of participants' plans for future PBL practices, we found differences between the two groups. The code 'How to apply PBL at different levels' was mentioned with high frequency in the 2018 group but with low frequency in the 2019 group. All participants in 2018 group worked together to build a systematic design of future PBL implementation, thus interviewees mentioned possible PBL practices at different levels. As illustrated by the quotes from Bella (2018):

> "Although we don't know how PBL will be applied in our university, I believe it's not innovative enough to just use PBL at the course level. We want to find new ideas about PBL reform at institutional level, and we have proposed possible strategies at the course level, intercourse level, programme level and interdisciplinary level."

Compared with the first group, participants from the 2019 group were divided into two groups and their reports mainly focused on applying PBL at the course level. In their opinions, teachers with PBL training in their home university are still the minority. With limited contributions from engineering staff, although they have a supportive policy from their university, it will not be easy to reform current curriculum design into PBL.

> "I think it's almost impossible to apply PBL at the institutional level. I can only control my courses. I plan to add PBL methods into my course, but I cannot push my colleagues to change their teaching practices."

As Bill (2019) said, their plans for future PBL implementation concentrated on how to utilize PBL in their own courses, which might be more feasible for them.

#### *4.4.2 Understanding of teamwork*

Another difference between the two groups concerns the understanding of teamwork. The code 'realize the importance of teamwork' had higher frequency in the 2018 group, and another code – identify the meaning of teamwork in Chinese context – was only mentioned in the 2018 group. A possible reason is that all seven participants from different subjects in the first group worked together and faced more of a clash of viewpoints, while the 2019 group was divided into two teams and participants reported less disagreement among team members.

In the 2018 group, disagreement and debate between participants inspired their discussion of the meaning of teamwork. They gradually realized the importance and benefits of teamwork, providing them with diverse angles to look at things and construct the meaning of their experience together, such as discussing the meaning of teamwork within the Chinese culture, just as Edward (2018) said:

> "Although we had teamwork experience before, we just divided the tasks and worked individually. In that case, we weren't familiar with others' work. But now, we work as a real team. We also summarized three key points of 'Chinese teamwork' in group discussion. I didn't realize those things before, but one of our team members comes from business administration, and he showed those new thoughts to us."

According to Edward, he and his team members conceptualized the meaning of successful teamwork based on their own experience and Chinese culture. Due to team members' diverse major backgrounds, they had more discussion and they learnt to think from interdisciplinary perspectives through the training programme.

## 5. Discussion

This study illustrates 13 Chinese teachers' motivation, learning outcomes and challenges in international pedagogical training programmes, providing empirical evidence on the benefits of the PBL training programmes. Motivated by interests in curriculum change and instruction skills development, participants reported their improvement of pedagogical knowledge and PBL skills, changes of attitudes in teaching and learning, and initial plans for course optimization and curriculum design. Taking the roles of both instructors and students in these programmes, challenges faced by engineering staff in pedagogical training were also reported, including transferring from traditional teaching to student-centred learning, language barriers, ineffective teamwork and difficulties of future PBL implementation in their institutions.

To answer the first research question, which is relating to participants' motivations for joining the PBL training programmes, we mapped their motivations from the institutional level (curriculum change, course optimization, etc.) to the individual level (knowledge acquisition, skills development, etc.). Most engineering staff had the intrinsic motivations to learn new pedagogical theories because pedagogical training programmes could serve as an effective pathway for them to improve the quality of learning and promote the educational changes from

traditional learning to PBL methods [28, 42]. Several participants from the 2019 group were inspired to join the training by their colleagues who participated in 2018. With those motivations of professional development,

In terms of the second research question, participants reported theoretical PBL knowledge, learning tools and facilitation skills as learning outcomes through the half-year training. Exposed to different PBL theories and practices, participants were able to build a systematic understanding of PBL methods and began to design their plans for PBL implementation. Through conducting team-based projects in the role of students, academic instructors not only developed better communication skills and teamwork skills, but also developed a deeper understanding of what instructions were needed by students. Thereby, they learned how to guide students' performance, foresee possible challenges faced by students and could provide helpful suggestions to smooth students' teamwork [43]. Moreover, through learning new pedagogical knowledge and instruction skills, teachers' beliefs in learning could be constantly changing [44]. Participants were reported to be able to think from the angle of learning theories via self-reflection and communication with pedagogical experts and team members with diverse subject backgrounds. Transforming from teacher-centred learning to student-centred learning, they realized the importance for students to conduct self-directed learning and active learning, supporting the view that pedagogical training could influence instructors' beliefs and practices in teaching and learning [45, 46].

However, although pedagogical training activities for engineering staff were pointed out as an effective way to enhance their identity as talent trainers and to promote the educational changes [17], challenges and difficulties were also reported, answering the third research question. Learning as students in these programmes, engineering staff faced challenges in teamwork processes, such as disagreement in group discussion, working with people with diverse backgrounds, and identifying the directions of projects, which were also faced by students in the PBL, reported in previous research [7, 42]. In addition, with the role of instructors, participants reported their concerns of possible challenges in implementing PBL, ranging from the individual level to the curriculum level. Although they have learnt theoretical knowledge and various PBL practices, some of them were still concerned as to whether they fully understood the PBL methods or whether they could apply PBL in an effective way, considering differences in students' learning habits and culture background between Denmark and China. For curriculum changes, as pointed out by prior research, engineering staff might face the challenges of designing suitable learning activities for project-oriented and problem-oriented PBL, choosing effective assessment methods, identifying the difficulty level of the problems for students, and having a heavy workload in PBL [6, 9, 47]. For higher educational institutions, in order to enhance the sustainability of PBL implementation, how to encourage academic staff in different departments to work together and apply PBL at both course level and the curriculum level are still significant challenges to be resolved, which not only need academic staff's efforts, but also requires a supportive policy at the university level [48].

With those challenges, suggestions are proposed for engineering staff, pedagogical training activity designers and educators, and higher educational institutions. Firstly, for engineering staff, with the goals of promoting educational changes, they should realize their role of educators for future talents instead of only identifying themselves as technical experts in specific fields [12]. In addition to the role of teachers who bring professional knowledge to students, they need to develop the identity of facilitators, who have a deeper understanding of the importance of transferable competences and know how to set appropriate learning objectives for students. It's also important for engineering staff to go to the outside world beyond their own educational system and culture background. Exposed in a totally new situation with a different institutional and national culture, instructors could have broader horizons and a deeper understanding of teaching and learning, which could influence their beliefs and practices in teaching and learning [49].

For programme designers, when designing PBL pedagogical training activities, it is important to let engineering staff involved in PBL and teamwork, which could help them accumulate practical experience of collaborative learning and self-directed learning [43, 50]. In those professional training activities, especially international programmes, opportunities for participants to work in local students' teams could help them better understand the PBL model and students' ways of learning [10], while this requires more efforts from programme designers and stronger support from policymakers. In order to achieve more effective communication and provide feasible suggestions for participants' future PBL practice, it is also important for programme designers and supervisors to pay more attention to participants' previous teaching experience, language proficiency levels, culture background and educational systems of participants' home countries. In addition to efforts from designers of pedagogical training activities, support

from universities is crucial [51]. At the institutional level, more opportunities for PBL pedagogical training for engineering staff are needed to help them transfer from traditional teaching to active learning [8, 33]. For feasible educational changes and effective PBL design for students' sustainable development, supportive policy and resources are essential to apply PBL at different levels [4, 48]. Motivated and supportive strategies from universities are needed to inspire engineering instructors' interests in developing their pedagogical competency and to encourage them to conduce educational practices of innovative learning methods [18]. In this study, with the strong support from the university, though this is still far from actual changes in learning practices, participants from NEU reported their confidence in overcoming reported challenges when transferring PBL methods to their institution.

The limitation of this paper is that we have not analysed participants' PBL practice and changes regarding students' learning experience and learning outcomes after they went back to China, which is an important part of the evaluation of pedagogical training activities but needs long-term research [24]. However, with close communication with the NEU, we know that the institution has introduced a supportive policy for PBL implementation and is building up the PBL centre, which is reported as a serious implementation of PBL methods. Another limitation of this study is the limited research sample due to the small size of the training programmes. For a higher level of the richness of data, we will continue exploring participants' learning experience and outcomes through PBL pedagogical training activities since the joint programme between NEU and AAU will be held every year. Future research could pay more attention to comparing learning outcomes and challenges between diverse groups of engineering staff and exploring their subsequent educational changes, PBL practices and students' learning quality.

## 6. Conclusion

This study investigated 13 Chinese engineering instructors' motivation for participating in pedagogical training, learning outcomes and challenges in the PBL training programmes. Theoretically, this study provides insights into the role of PBL training programmes for engineering staff's professional development. Empirically, evidence of engineering staff's learning experience and learning outcomes in these training programmes were provided and illustrated in detail. Through PBL pedagogical training, academic staff could learn pedagogical knowledge and PBL skills, change their attitudes in teaching and learning, and develop interests in PBL methods. The design of future PBL implementation plans were highlighted as an important learning outcome by participants to improve students' learning in their institution. In pedagogical training programmes, challenges faced by academic staff, such as changing learning and teaching beliefs, transferring from traditional teaching to student-centred learning, language barriers, ineffective teamwork, were also reported in this study. More efforts from staff training researchers and educators are needed to improve future PBL pedagogical training activities, inspire academic staff's motivation for pedagogical learning, and therefore promote curriculum changes for PBL implementation.

## References

1. D. E. Dumitru, Reorienting higher education pedagogical and professional development curricula toward sustainability: A Romanian perspective, *International Journal of Sustainability in Higher Education*, **18**(6), pp. 894–907, 2017.
2. J. Ödalen, D. Brommesson, G. Ó. Erlingsson, J. K. Schaffer and M. Fogelgren, Teaching university teachers to become better teachers: The effects of pedagogical training courses at six Swedish universities, *Higher Education Research & Development*, **38**(2), pp. 339–353, 2019.
3. M. F. Pajares, Teachers' beliefs and educational research: Cleaning up a messy construct, *Review of Educational Research*, **62**(3), pp. 307–332, 1992.
4. J. Chen, A. Kolmos and X. Du, Forms of implementation and challenges of PBL in engineering education: A review of literature, *European Journal of Engineering Education*, **46**(1), pp. 90–115, 2021.
5. K. Edström and A. Kolmos, PBL and CDIO: Complementary models for engineering education development, *European Journal of Engineering Education*, **39**(5), pp. 539–555, 2014.
6. A. M. Clyne and K. L. Billiar. Problem-based learning in biomechanics: Advantages, challenges, and implementation strategies, *Journal of Biomechanical Engineering*, **138**(7), pp. 1–9, 2016.
7. E. Bani-Hani, A. Al Shalabi, F. Alkhatib, A. Eilaghi and A. Sedaghat, Factors affecting the team formation and work in project-based learning (PBL) for multidisciplinary engineering subjects, *Journal of Problem-Based Learning in Higher Education*, **6**(2), pp. 136–143, 2018.
8. C. K. Chan, Facilitators' perspectives of the factors that affect the effectiveness of Problem-based learning process, *Innovations in Education and Teaching International*, **53**(1), pp. 25–34, 2016.
9. S. C. Dos Santos, M. M. Batista, A. C. Cavalcanti, J. O. Albuquerque and S. R. Meira, Applying PBL in software engineering education, *In Proceedings of 2009 22nd Conference on Software Engineering Education and Training*, pp. 182–189, 2009.

10. R. E. Gibbons, S. M. Villafañe, M. Stains, K. L. Murphy and J. R. Raker, Beliefs about learning and enacted instructional practices: An investigation in postsecondary chemistry education, *Journal of Research in Science Teaching*, **55**(8), pp. 1111–1133, 2018.
11. S. Pedersen and M. Liu, Teachers' beliefs about issues in the implementation of a student-centered learning environment, *Educational Technology Research and Development*, **51**(2), pp. 57–72, 2013.
12. R. M. Felder, R. Brent and M. J. Prince, Engineering instructional development: Programs, best practices, and recommendations, *Journal of Engineering Education*, **100**(1), pp. 89–122, 2011.
13. A. Guerra and C. C. M. Spliid, Academic staff expectations when enrolling in pedagogical development course for curriculum change, *In Proceedings of the 7th International Research Symposium on PBL: Innovation, PBL and Competences in Engineering Education*, pp. 562–572, Beijing: Aalborg University & Tsinghua University, 2018.
14. J. Hunzicker, Effective professional development for teachers: A checklist, *Professional Development in Education*, **37**(2), pp. 177–179, 2011.
15. UNESCO, *Education for Sustainable Development Goals Learning Objectives*, Education Sector, UNESCO, https://unesdoc.unesco.org/ark:/48223/pf0000247444, Accessed 2017
16. S. Bickerstaff and M. S. Cormier, Examining faculty questions to facilitate instructional improvement in higher education, *Studies in Educational Evaluation*, **46**(1), pp. 74–80, 2015.
17. M. G. Minin, V. S. Pakanova, G. F. Benson and E. N. Belomestnova, Continuing pedagogical staff development in engineering university, *In Proceedings of 2013 International Conference on Interactive Collaborative Learning*, IEEE Press, pp. 458–461, 2013.
18. M. Fullan, *Teacher Development and Educational Change*, New York: Routledge, 2014.
19. S. Van Schalkwyk, B. Leibowitz, N. Herman and J. Farmer, Reflections on professional learning: Choices, context and culture, *Studies in Educational Evaluation*, **46**, pp. 4–10, 2015.
20. J. L. Pecore, Beyond beliefs: Teachers adapting problem-based learning to preexisting systems of practice, *Interdisciplinary Journal of Problem-Based Learning*, **7**(2), pp. 7–33, 2013.
21. C. Luppertz, S. Himmel, N. Ouehrani and M. Winzker, Sharpening the educational toolset: Promoting professional development of university lecturers. *In Proceedings of 2016 IEEE Global Engineering Education Conference*, IEEE Press, pp. 100–104, 2016.
22. E. L. Meyen and C. H. Yang, *Barriers to Implementing Large-Scale Online Staff Development Programs for Teachers*, The University of Kansas, 2005.
23. C. Rogerson and E. Scott, Effective online staff training: Is this possible? *In Proceedings of World Academy of Science, Engineering and Technology*, World Academy of Science, Engineering and Technology (WASET), pp. 1396–1408, 2013.
24. T. R. Guskey, *Evaluating Professional Development*. Thousand Oaks: Corwin Press, 2000.
25. K. Trigwell, Evaluating the impact of university teaching development programmes: Methodologies that ask why there is an impact. In Simon, E., & Pleschová, G. (Eds.), *Teacher Development in Higher Education: Existing Programs, Program Impact, and Future Trends*, New York: Routledge, pp. 257–273, 2013.
26. R. Brent and R. M. Felder, A model for engineering faculty development, *International Journal of Engineering Education*, **19**(2), pp. 234–240, 2003.
27. L. M. Desimone, Improving impact studies of teachers' professional development: Toward better conceptualizations and measures, *Educational Researcher*, **38**(3), pp. 181–199, 2009.
28. Y. Seyoum, Staff development as an imperative avenue in ensuring quality: The experience of Adama University, *Education Research International*, pp. 1–17, 2012.
29. L. G. Coelho and J. A. B. Grimom, Institutional policies on teacher training and engineering teachers' training. *In Proceedings of 2014 International Conference on Interactive Collaborative Learning*, pp. 17–20, 2014 October.
30. J. Froyd, J. Layne, D. Fowler and N. Simpson, Design patterns for faculty development, *In Proceedings of 2007 37th Annual Frontiers in Education Conference-Global Engineering*, 2017.
31. A. Lobbestael and M. Sleep, Investigating the effectiveness of new geotechnical engineering problem-based learning modules for student comprehension and attitude at two universities, *In Proceeding of 2016 ASEE Annual Conference*, 2016.
32. G. Gweon, S. Jun, S. Finger and C. P. Rosé, Towards effective group work assessment: Even what you don't see can bias you, *International Journal of Technology and Design Education*, **27**(1), pp. 165–180, 2017.
33. G. Lutsenko, Case study of a problem-based learning course of project management for senior engineering students, *European Journal of Engineering Education*, **43**(6), pp. 895–910, 2018.
34. S. K. R. Karri and S. Kode, Effectiveness of 'Learning by Doing' methodology in training programs: An evaluation of a teacher training program for information technology education, *In Proceedings of 2011 IEEE 11th International Conference on Advanced Learning Technologies*, pp. 227–231, 2011.
35. O. Vinther and A. Kolmos, National strategies for staff and faculty development in engineering education in Denmark, *Global Journal of Engineering Education*, **6**(2), pp. 161–166, 2002.
36. A. Kolmos, X. Du, M. Dahms and P. Qvist, Staff development for change to problem-based learning, *International Journal of Engineering Education*, **24**(4), pp. 772–782, 2008.
37. A. Kolmos, C. Rump, I. Ingemarsson, A. Laloux and O. Vinther, Organization of staff development: Strategies and experiences, *European Journal of Engineering Education*, **26**(4), pp. 329–342, 2002.
38. L. Brodie and H. Jolly, Developing and evaluating tutor training for collaborative teaching, *In Proceedings of 2012 Frontiers in Education Conference Proceedings*, pp. 1–6, 2012.
39. J. W. Creswell, W. E. Hanson, V. L. Clark Plano and A. Morales, Qualitative research designs: Selection and implementation, *The Counselling Psychologist*, **35**(2), pp. 236–264, 2007.
40. K. M. MacQueen, E. McLellan, K. Kay and B. Milstein, Codebook development for team-based qualitative analysis, *Cultural Anthropology Methods*, **10**(4), pp. 31–36, 1998.
41. S. B. Merriam, *Qualitative Research in Practice: Examples for Discussion and Analysis*, San Francisco: Jossey-Bass Inc, 2002.
42. K. Kjellberg, T. Adawi and K. Brolin, Challenges in implementing PBL: Chalmers formula student as a case. *In Proceedings of the 43rd Annual SEFI Conference*. https://www.sefi.be/wp-content/uploads/2017/09/56749-M.- KJELLBERG.pdf Accessed September 2015.

43. M. Dancy, C. Henderson and C. Turpen, How faculty learn about and implement research-based instructional strategies: The case of peer instruction, *Physical Review Physics Education Research*, **12**(1), pp. 010110, 2016.
44. R. Kane, S. Sandretto and C. Heath, Telling half the story: A critical review of research on the teaching beliefs and practices of university academics, *Review of Educational Research*, **72**(2), pp. 177–228, 2002.
45. V. Mihaela and B. Alina-Oana, When teachers' pedagogical beliefs are changing?, *Procedia-Social and Behavioral Sciences*, **180**, pp. 1001–1006, 2015.
46. A. Saroyan and K. Trigwell, Higher education teachers' professional learning: Process and outcome, *Studies in Educational Evaluation*, **46**, pp. 92–101, 2015.
47. R. J. Hugo, R. W. Brennan and P. Gu, Quantitative indicators for assessing the effectiveness of project-based learning experiences, *In Proceedings of the 8th International CDIO Conference*. Brisbane: CDIO Organization, 2012.
48. A. Arman, Students' attitudes toward problem-based learning: Analog electronic course in the electrical engineering programs in PPU case study, *Journal of E-Learning and Higher Education*, **3**(14), pp. 1–9, 2019.
49. X. Du, K. K. Naji, U. Ebead and J. Ma, Engineering instructors' professional agency development and identity renegotiation through engaging in pedagogical change towards PBL, *European Journal of Engineering Education*, https://www.tandfonline.com/doi/full/10.1080/03043797.2020.1832444, Accessed from October 2020.
50. K. J. Nasr and B. H. Ramadan, Impact assessment of problem-based learning in an engineering science course, *Journal of STEM Education*, **9**(3), pp. 16–25, 2008.
51. S. Bickerstaff and M. S. Cormier, Examining faculty questions to facilitate instructional improvement in higher education, *Studies in Educational Evaluation*, **46**(1), pp. 74–80, 2015.

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