

## Examining the Application of a Similar Problem-Based Learning Procedure in Teacher Education and Engineering Education Programs

Yasemin Kirkgöz | Çukurova University, Turkiye

Burcu Turhan\* | Hatay Mustafa Kemal University, Turkiye

### Abstract

This multiple case study aims to describe how Turkish students in English Language Teaching (ELT) and Electrical-Electronics Engineering Program (EEP) conceive of Problem-based Learning (PBL), and how they experience their studies within a PBL-oriented curriculum. With the inclusion of these two cases into the study, the rationale is to represent two different educational perspectives and to obtain in-depth, extensive, and comparable data. The participants from the ELT and EEP were first-year students who pursued courses in English, which is taught as a foreign language in Turkiye. During one semester, the data were collected through open-ended questionnaires and reflection reports, both of which were analyzed qualitatively with an interpretative phenomenological approach. The results revealed commonalities as well as differences in how students in these two comparable programs perceived and experienced PBL. Commonalities were many in number and involved positive perceptions along with beneficial experiences of PBL. Yet, differences only stemmed from the number of frequencies of some similar issues raised by both groups of students. The most eye-catching difference was that the EEP students emphasized the anticipated benefits of PBL less frequently than the ELT students did. However, at the end of the process, the EEP students proposed benefits gained from PBL more frequently.

---

\* Corresponding author:  
Burcu Turhan, Email: [burcu.oyp@gmail.com](mailto:burcu.oyp@gmail.com), [burcuturhan@mku.edu.tr](mailto:burcuturhan@mku.edu.tr)

**Keywords:** Electrical-Electronics Engineering Program (EEP), English Language Teaching (ELT), Teacher Education, Engineering Education, Problem-based Learning (PBL), Perceptions, Learning Experiences

## Introduction

Complexity of problems faced and the authenticity of settings where practices are made in various disciplines is a vital issue that needs to be addressed by educators. Within the contexts of education and engineering, sustainability and social benefit are the primary concerns for growing professional individuals. In education, with the perpetual influences of globalization in information societies, the role of teachers in moderating society necessitates reforms in teacher education (Tarman, 2010). To provide sustainability in educational development, teacher education programs are of noteworthy significance (Katitia, 2015). In the field of education, students need to be trained in a way that they become autonomous, active, cooperative, and skillful problem-solvers (Budaghyan, 2015). Identically, engineering requires one to empower his/her agency through individual development in a community. This empowerment entails the talents of mentoring, networking, and shared reflections. Accordingly, the changing roles of teachers and engineers now lead educators to design and implement student-oriented learning, especially at the undergraduate level. To meet such a need, Scott (2015) suggests that PBL is one of the most ideal models which can be compatible with twenty-first-century pedagogy since, as Hatisaru (2015) proposed, it is effective in promoting such skills as questioning, access to information, critical thinking, learning to learn and self-efficacy.

Aligning with the theories of socio-constructivism (Anderson, 2005), PBL is a well-known alternative approach to traditional disciplinary based educational programs in higher education (Dahlgren & Dahlgren, 2002). It was first implemented in medical education at McMaster University in Canada about forty years ago. At that time, PBL was recognized as an educational method designed to facilitate student motivation and interest in clinically based situations (Happell, 1991). It is regarded as representing a shift from the traditional perspective of higher education where much attention has been paid to teachers and teaching methods to a perspective that gives priority to student learning. Regarding learning/teaching style, it is a learning method based on the principle of using problems as a starting point for the acquisition and integration of new knowledge (Barrows, 1980). Among the diverse key pedagogical principles of PBL, Kolmos and DeGraaff (2014) categorize PBL approaches into three dimensions: the learning approach (Problems identified at the beginning shape the purpose of the whole learning; and it contains

identification, analysis, and solution phases), the social approach (Dialogic interaction takes place between team members while solving problems), and the content approach (Various theories specific to multiple disciplines are applied for problem-solving). Apart from these, Kolmos and DeGraaff (2014) claim that PBL is one of the most successful approaches that could yield positive outcomes in preparing engineers for their careers. Similarly, via PBL, teacher knowledge and skills can be fostered through authentic scenarios, group collaborations and self-directed learning (Borhan, 2014).

PBL is a more useful instructional method compared to lecture-based instruction regarding the development of skills and long-term retention (Strobel & van Barneveld, 2009). Particularly in teacher education, as a way to close the gap between theory and practice, PBL is an important tool to make student teachers use theoretical and practical resources in generating appropriate solutions (Kırkgöz, 2015; Pourshafie & Murray-Harvey, 2013). Kırkgöz (2017, 2018) also acknowledged that PBL is an effective instructional method endowing student teachers with diverse perspectives. Through solving real-life problems, student teachers become capable of transferring teaching skills to professional life (Borhan, 2014). In parallel with this, Kırkgöz and Turhan (2021) claimed that student teachers who are involved in PBL could gain more than theoretical knowledge. Moreover, PBL enables student teachers to think critically while solving problems. Namely, PBL is important for teacher education because it makes it possible for students to improve their analysis and evaluation skills, but still, there are some blank spaces in the realization of PBL in teacher education (Major & Mulvihill, 2018). To exemplify, one of the prerequisites of PBL is students' ability to be self-directed in learning; and instructors' first duty should be ensuring that students have this ability at the beginning of the PBL process (Kırkgöz & Turhan, 2021). This is because instructors should implement alternative learning strategies for students (English & Kitsantas, 2013). To this end, teacher education courses could be designed with the inclusion of technology-enhanced PBL practices (So & Kim, 2009) to make PBL more appealing to twenty-first-century students.

In engineering, there exists a need to move away from traditional learning methods toward PBL methods, especially the need to equip students with teamwork skills. This is because PBL necessitates students to participate in group work where their motivation and performance are expected to boost; however, either students do not have positive feelings toward their prior teamwork experiences or they have not had any experiences with teamwork and PBL (Chen et al., 2021). If the ones who have no previous experiences in PBL do not receive PBL skills training, they face various challenges in coping with conflicts in groups (McQuade et al., 2018). Another vital requirement of PBL might be self-learning skills, and some scholars assume that it is hard for

students to solve real-life problems in a self-learning process (e.g. Bledsoe & Flick, 2012; Hu et al., 2014; Lutsenko, 2018). More importantly, students need to reflect on their own progress and achievements to obtain efficacious learning gains from PBL (Gratchev & Jeng, 2018). In order to meet such requirements, students should receive continuous guidance on group work, self-learning and reflection. To accomplish these, specific lectures, workshops, or seminars could be added to the PBL-oriented curriculum through introducing theories of communication and problem-solving as a part of the professional community. Otherwise, PBL does not yield fruitful consequences in the long run, and obstacles may arise.

In the implementation of PBL in engineering, one of the main obstacles is the lack of community and industry involvement, which results in only a few opportunities for engineer candidates to put their factual knowledge into practice (Roach et al., 2018; Ruhizan et al., 2009) although they should be trained through PBL so that they can successfully fulfill the requirements of their profession. During and after such training, formative assessment practices are crucial in well-designed PBL systems (Thomas, 1997). Besides, such control tools as self-assessment, peer assessment, and meeting records should be utilized to gain a deeper understanding of student learning in PBL (Palmer & Hall, 2011; Qattawi et al., 2014). Along with such assessment tools, developing critical thinking skills through PBL is vital for an engineer's whole career (Said et al., 2005; Yadav et al., 2011). As for previous PBL studies in EEP, Bijzak (2008) highlighted students' higher test results and positive attitudes of both students and faculty members toward PBL. Likewise, de Camargo Ribiero (2008) postulated that students find PBL more engaging thanks to the construction of their own knowledge instead of only absorbing the teacher's words, as well as the improvements in research and communication skills. Moreover, Canavan (2008) concluded that PBL is an effective pedagogical tool enabling students to think deeply, feel more responsible toward their work and become effective communicators. In spite of these beneficial aspects of PBL, students' reports revealed that they learned more in traditional lectures because PBL did not help them become familiar with basic concepts (Yadav et al., 2011). This could be because of the non-existence of proper scaffolding, which is central to preventing students from feeling frustration in PBL (Yadav, 2006).

In light of this review, the present study aims at understanding how PBL is realized in two different academic contexts. The rationale of involving education and engineering in the study is that they are similar because both prioritize the practical side of the profession rather than equipping students only with theoretical knowledge. Conversely, they are different because education is more directly related to human beings and social aspects of learning; yet, engineering requires one to work with both humans and non-

living things. Moreover, the philosophy dominant in education is largely constructivist with multiple realities, though it is more individualistic with more unaltered realities in engineering. The study can also be regarded as valuable since it investigates the outcomes of PBL in courses taught in a foreign language at tertiary level. The purposes of this study are to evaluate the possible shifts in students' perspectives before and after an experience with PBL and to compare the commonalities and differences between the perceptions and experiences of the ELT and EEP students in relation to PBL. Depending on these purposes, the following research question was formulated:

- What are the commonalities and differences in the ELT and EEP students' perceptions and experiences in relation to PBL?

## Method

### Research design

The present study was designed as a multiple case study in order to have an in-depth investigation into perceptions and experiences of ELT and EEP students in a PBL environment. Multiple case studies explore differences within and between cases with the intent of replicating results across cases in a certain period of time (Yin, 2003). In this direction, we aimed to ascertain whether similar PBL implementations in different undergraduate programs result in any similarities and differences. Beyond that, we aimed to either accept or refuse the propositions concerning the success or failure of the implementations. The implementations of the curriculum in both programs took place in consecutive semesters; one (EEP) in the fall term and the other (ELT) in the spring semester. This was to prevent the time lag between the implementations. In fact, a PBL implementation that is compatible with the twenty-first-century pedagogy (Scott, 2015) seems to be reasonable for teacher and engineer education at tertiary level, each of which adapts differing views toward learning but attaches great importance to making real-life like practices. Beyond that, examining the implementation of a similar PBL procedure in a specific context would be a wise act to equip teacher and engineer candidates with the practice-oriented qualifications necessary for surviving in their future community of practice. Overall, the ultimate aim of this multiple case study is to determine whether we need to tailor one of the PBL-oriented curricula based on the predictions of similar and contrasting results across cases.

## Participants

Participants were all freshmen from the ELT and EEP departments at a state university in Türkiye. 58 students from the ELT department and 68 students from the EEP were included in the study; in total, 126 volunteer students, whose average age was 21.5, took part in the study. We did not find it necessary to equalize the number of students in the groups so as not to intervene with the integrity of the study in its natural context. Both groups of students followed their courses through English. The majority of the participants had experiences in some kind of project; however, none of them experienced a PBL project. Due to their unfamiliarity with PBL, we assumed that the initial stages of the projects would be an adaptation period when such qualifications as self-directed decisions, higher-order thinking, and cooperation were dominant.

## Procedures

In the scope of this study, PBL was incorporated into both a Reading-Writing course for ELT students and the Technical English course for EEP students. These courses were delivered by the first author of this study through the medium of English language. The ultimate objective of the steps taken during the study was to compare students' initial and final perceptions and experiences in a fourteen-week course. The weekly schedule of both courses consisted of three-hour PBL sessions and one-hour lectures. The PBL sessions focus on certain key features of PBL as listed below:

- Working in groups to find solutions to complex problems (Ferreira & Trudel, 2012)
- Giving value to learning (Tan, Van der Molen & Schmidt, 2016)
- Coping with learning challenges (Tan, Van der Molen & Schmidt, 2016)
- Resorting to higher-order thinking skills (Jerzembek & Murphy, 2013)
- Self-directed learning (English & Kitsantas, 2013)

The first step was to orient the students toward the logic of PBL in both theory and practice. The students were instructed about the educational principles and implementation steps of PBL. This orientation gave the students an understanding of educational methods and theory at the pre-exposure phase. Afterwards, throughout 14 weeks, the students were involved in the PBL sessions that were accompanied by the application of pre- and post-course questionnaires and weekly reflection reports. Four classes (Two ELT classes and two EEP classes), in the form of 45-minute sessions, were conducted three times a week. Students worked in groups most of the class time and their project topics concentrated on authentic problems related to their disciplines. Each group received the tutorials from the first of the study. The tutor was an indirect facilitator, rather than being directive, who developed the students' conceptual

schemata through discussions. During the PBL sessions, the first author, who is an experienced academician and has a number of studies on PBL, was not only a model of an effective problem-solver but also a model of a critical thinker and professional communicator. Most importantly, the first author guided the problem-solving procedures of the ELT and EEP students in different manners due to the complexity of the problems and the availability of diverse solutions. Roughly, we realized that the EEP students tended to raise more specific problems accompanied by few alternative solutions. However, the ELT students were more inclined to select well-rounded problems that might be dealt with many possible solutions. Therefore, it was more demanding for the first author to facilitate the ELT students' PBL experiences. Besides, the second author made herself familiar with the main tenets of the PBL implementations thanks to the regular meetings with the first author; and collaborated with the first author for the analyses and reporting of the findings.

#### Data collection tools

Designed by the authors, pre- and post-course questionnaires and reflection reports were the primary data sources of the study. The pre-course questionnaire was administered during the initial stage of the implementation to reveal what students understood from the concept of PBL as a new learning method and what they felt about being involved in a PBL project. In order to examine how PBL influenced students' perceptions and experiences, the post-course questionnaire was administered at the end of the course. To this end, students shared their opinions on the advantages and disadvantages of being a part of PBL projects. Additionally, they reflected on their experiences with this novel learning method in their weekly reflection reports examining what students carried away with them after the sessions. In formulating questions included in each data collection tool, expert opinions were obtained. Figure 1 illustrates the content and implementation sequence of the data collection tools:

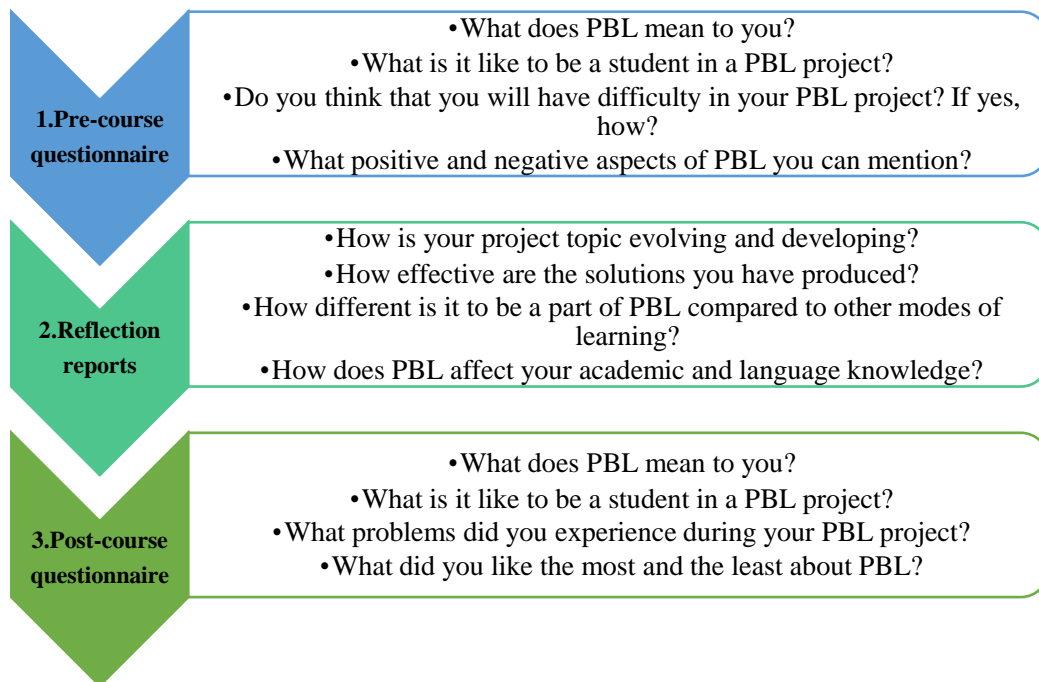


Figure 1. The content and implementation sequence of data collection tools.

### Data analysis technique

The process of analysis was an iterative and cyclical movement between the individual data elicited from the questionnaires and reflections. The construction of an interpretative narrative which portrays the characteristic similarities and differences of the answers within each group (Dahlgren & Dahlgren, 2002) was the aim of all the analyses. Student responses in the open-ended questionnaires and reflection reports were analyzed qualitatively with an interpretative phenomenological approach focusing on the individual students' comments on his/her experiences. Each data source was thoroughly read, coded and subjected to content analysis to identify the most significant statements and meaningful units. A cross-case, interpretative and preliminary narrative was constructed, based on the merged series of selected statements for each group, respectively. The preliminary narratives were then condensed for expressing the typical and common traits of each group. Common themes in the two groups were used as a structure for comparison and determining the differences. To ensure trustworthiness, two independent coders analyzed the data. One coder, the first author of this study coded the entire data set; and the second author coded 80% of the whole data. Overall, there was 87% inter-coder agreement, which shows that the data analysis resulted in a trustworthy data interpretation process. The disagreements about the codes were only a few and were resolved through joint discussion. As for reporting of the results, the frequencies and percentages were shared to present the main themes; however,



sub-themes were not quantified. Instead, we reported the most prominent sub-themes in tandem with convenient excerpts.

## Findings

In this section, first, findings related to pre- and post-course questionnaires are reported. Second, analyses of reflection reports are presented. All the themes emerged in accordance with the research scope with a specific focus upon perceptions and experiences. Overall, the elicited themes revolved around positive, negative or typical aspects of PBL, feelings and collaboration during the PBL project. Table 1 shows the themes constructed from the evaluation of both pre- and post-course questionnaires for the ELT and EEP students.

The results of the pre-course questionnaire	
ELT	EEP
Anticipated benefits (f:62, 28%)	Features of PBL (f:48, 28%)
Features of PBL (f:47, 21%)	Group work (f:40, 23%)
Feelings toward PBL (f:44, 20%)	Feelings toward PBL (f:38, 22%)
Group work (f:43, 20%)	Anticipated benefits (f:35, 20%)
Initial difficulties experienced (f:23, 11%)	Initial difficulties experienced (f:12, 7%)
The results of the post-course questionnaire	
ELT	EEP
Benefits gained (f:51, 28%)	Benefits gained (f:84, 36%)
Feelings toward PBL (f:48, 26%)	Feelings toward PBL (f:56, 24%)
Features of PBL (f:26, 14%)	Features of PBL (f:38, 16%)
Favorable and unfavorable aspects of PBL (f:26, 14%)/(f:3, 2%)	Favorable and unfavorable aspects of PBL (f:23, 10%)/(f:8, 3%)
Group work (f:25, 13%)	Group work (f:18, 8%)
Difficulties experienced (f:6, 3%)	Difficulties experienced (f:6, 3%)

*Table 1. The results of the pre- and post-course questionnaires*

As is evident in Table 1, five themes from the pre-course questionnaire results and six themes from the post-course questionnaire results emerged. The theme “anticipated benefits” in the results of the pre-course questionnaire is categorized under the theme “benefits gained” in the post-course questionnaire. Besides, we have one new theme at the end of the study, which is “favorable and unfavorable aspects of PBL”. Table 1 demonstrates that in the initial stages, the ELT students mentioned anticipated benefits of PBL more frequently, yet the EEP students paid more attention to the features of PBL. This

may arise from the ELT students' possible tendency to think about the usefulness of certain teaching strategies, as they are more interested in the educational profits of learning procedures. On the other hand, the EEP students might care more about the characteristics of a new learning experience in which they are involved. Even so, both groups expressed opinions on feelings toward PBL, group work and difficulties as well as benefits and features of PBL in the pre-course questionnaires. The initial difficulties experienced were fewer for the EEP students. At the end of the process, the ELT and EEP students took into consideration the same issues with the issues they expressed in the initial stages of the study. Additionally, both groups raised a new issue regarding favorable and unfavorable aspects of PBL. It is observed that the EEP students focused on benefits gained more frequently than the ELT students did although it was the EEP students who made fewer references to the benefits in the initial stages. The frequencies of the other themes for both groups were similar. As for comparing the total results of the pre- and post-course questionnaire, it can be claimed that the initial difficulties experienced were more numerous compared to the difficulties experienced toward the end of the process. This is promising since both groups of students appear to gain a noteworthy familiarity with PBL and accumulate professional knowledge through PBL.

### Theme 1: Features of PBL

For both groups of students, the theme of "features of PBL" was developed around the concepts of authenticity, relevance, constructing links with the real world, and awareness of the PBL philosophy before and after the PBL projects. In addition to these, in the post-course questionnaires, students expressed that PBL made them more independent in taking on a personal responsibility for the development of their projects; and they believed that PBL was applicable to the other courses as shown below.

*"The process of defining a problem that you showed us, to me, was very valuable, in that I started thinking about this not only in this course but in every assignment for other subjects." (ELT-Student19/post-course)*

The EEP students' initial perceptions of PBL are primarily characterized by the authenticity of the studies. The authenticity mainly functions as a tool for the students in choosing a topic of current relevance to offer solutions to daily problems encountered. Namely, the aspects of relevance and authenticity go hand-in-hand because PBL engages students in learning information in ways that are similar to the ways in which it will be recalled and employed in future real-life situations and assesses learning in ways, which demonstrate understanding and not mere acquisition. The following excerpt illustrates these.

“After some research, we all agreed on ‘anti-waves’. This was necessary because when we concentrate on our lesson, someone’s mobile phone rings off and our attention gets distracted. Therefore, we are trying to solve this problem by inventing a machine. This device will help us concentrate on the lesson and we won’t have to deal with such distractions anymore.” (EEP-Student21/pre-course)

Authenticity is also expressed in the sense that the EEP students get a feeling of coping with the kind of problems they will encounter later as professionals, in other words, as a link to their professional lives. Likewise, the ELT students believe that gaining some skills towards solving a real-life problem would have a great relevance to their future professional life as the skills and information they acquired would help them while teaching. The following excerpt gives a representative image of this.

“We are working on a real-life problem, which is the insufficiency of classroom equipment. Knowing what kind of problems our education system has will help me now and, in the future, when I become a teacher.” (ELT-Student13/pre-course)

It has also been noted that, even during the first month of the PBL project and at the end of it, both ELT and EEP students mentioned an awareness of PBL philosophy. A relevant excerpt is as follows:

“This project is quite different from the other projects I have done so far, as it’s based on daily facts, not imaginary situations...” (EEP-Student22/post-course)

## Theme 2: Group work

This theme clearly demonstrates that students recognized how PBL involves teamwork, cooperation and responsibility toward others for both groups of students. Students generally found it important to learn from group members, learn how to effectively work in a group, how to deal with conflict management, to gain a sense of responsibility and to promote friendship. The first part of the following excerpt emphasizes the benefits of working together whereas the latter part explains the frustration involved.

“Preparing this project as a group is useful in many ways. It develops our thoughts and personality. We learn how to help each other. I feel more creative. In the group, we learn new ideas from each other. We feel proud of what we do, but sometimes there are some disagreements that discourage us from progressing ahead.” (EEP-Student12/pre-course)

Specifically, for the EEP students, PBL demanded a transition from the habit of working on their own to working in groups; and they accepted the tutorials as a significant learning environment because during tutorials, fellowship was fostered. They regarded the tutorial as an instrument for tuning their understanding of concepts and strategies for problem-solving and appreciating different points of view. Thus, tutorials fulfill several functions by giving opportunities for comparing one's own understanding with that of others. The following excerpt is a concise summary of all these.

“However, we get rid of our concerns and confusion about the conflicts in the tutorials where we have the chance to give constructive feedback and reach a common understanding. It was a unique experience, indeed.” (EEP-Student51/post-course)

On the other hand, especially in the beginning stages of PBL; the shift from individual work to group work made things harder for both groups of students who had been accustomed to working on their own. Though it was the students' first experience with working in groups, initial outcomes demonstrate that many students recognized and valued cooperation and teamwork. Some students, though, felt uneasy about adapting to working as a group.

“At first, it was hard to adapt with my group friends as everybody had different ideas about the project. But later on, it became more and more enjoyable to take part in such a group activity.” (ELT-Student4/pre-course)

Different from all these, an ELT student reported that group work is one of the best ways to teach a subject. Most ELT students stated that PBL provided peer and group interactions useful to them in completing the assignment; and similarly, for the EEP students, working in a group did not cause obstacles that might reduce the quality of their work. The below excerpt presents evidence for those findings.

“Our topic was problematic student-teacher relationships. I learned interesting ideas from my friends, and they broadened my perspective. I now find myself better at taking responsibilities in a group. At first, I thought it would be hard to work in groups, and I thought I would be unsuccessful. My friends gave me a lot of courage and I was sure I would succeed. I decided to use PBL as my favorite teaching method in future.” (ELT-Student14/post-course)

### Theme 3: Feelings towards PBL

This theme demonstrated how students felt about taking part in the PBL project. The EEP students mostly felt challenge accompanied by determination,

satisfaction of having chosen a topic, self-confidence, excitement, pride, anxiety, or nervousness. Identical feelings were also detected for the ELT students such as confidence, challenge accompanied by determination, enjoyment, satisfaction, pride, worry, or anxiety. Generally, positive ones toward the end of the projects replaced negative feelings. Most importantly, both ELT and EEP students declared that they acquired a new identity, as they would serve for the benefit of the society. The related excerpts are presented below.

“The topic of our project is “the education of disabled children”. It is a crucial problem for Turkiye. To solve the related problems, we have interviewed some people. Besides, we have taken some photos and talked to the disabled people in schools. I hope, at the end of this study, we will make great contributions to the problems of disabled children.” (ELT-Student23/post-course)

“While working on our PBL project, I had the spirit of a researcher. Now, I am looking at problems from an entirely different perspective. Even sometimes, I am not angry about problems because I know how to solve them...” (EEP-Student30/post-course)

Another challenge for both groups of students was the confusion experienced because of the initial worries about the PBL process followed by the feeling of determination and satisfaction as is clear below.

“At first, I thought it would be a difficult job, so I worried a lot... but as we moved further, I saw that we could do it, and I started to relax. Despite all the difficulties, I think our project will teach us about real life. Therefore, we are all determined to move on by doing extensive research...” (ELT-Student46/pre-course)

#### **Theme 4: Anticipated benefits/Benefits gained**

Anticipated benefits/benefits gained include the contributions of PBL to research and language skills. For the EEP students, the potential research skills ranged from organizing information, accessing information, effective use of the Internet, and use of journals as information sources. As for the contribution to language skills, they emphasized that their vocabulary knowledge was well developed; they improved their writing skills (especially in terms of sentence construction), and their presentation skills were fostered. The following excerpts summarize the benefits expressed by the EEP students.

“This project is useful in many ways: it will help us improve our English. The most important part of this project is to develop our research and information organization skills using various sources.” (EEP-Student19/pre-course)

“I believe that PBL will help us in many ways in future because as engineer candidates, we need to do a lot of research. With the help of this specific method, we learned innovative techniques to conduct quality research.” (EEP-Student7/post-course)

Besides, the ELT students’ anticipation of the benefits did not greatly differ from those of the EEP students. Many ELT students were also aware of the benefits of PBL regarding subject-specific knowledge development as clearly shown below.

“For me, we are involved in such a project that will make us aware of how certain things (creating an electronic dictionary) will make language learners’ lives easier, and this project will help us be equipped with information about our profession.” (EEP-Student35/pre-course)

Different from the previous statements, in the case of the ELT students, research skills gained priority over language skills, particularly in terms of developing a deeper understanding of how to carry out research as evidently expressed in the following excerpt.

“In PBL, you have to explore yourself... in the lectures, we just take information and write it down, but PBL makes us go into more details with the help of hands-on experiences.” (ELT-Student51/post-course)

#### **Theme 5: Initial difficulties experienced/Difficulties experienced**

Difficulties can be grouped as topic selection, finding sources, being incompetent in language skills, time constraints, dealing with the feeling of uncertainty, and achieving consensus on the divergent ideas. The difficulty in choosing authentic topics was also associated with reaching appropriate sources as highlighted in the excerpts below.

“The most difficult part of it was to choose the problem. As a result of an agreement with my group friends, we decided to work on the harmful software on the web, which could be accepted as an up-to-date topic.” (ELT-Student29/post-course)

“Having decided on our topic, the next difficulty was where and how to find suitable documents for this topic. We soon found out that the answer to this question was hidden in our research topic “Internet”. We found the rest of the documents from journals and the library, and we had to do some translation as well....” (EEP-Student17/post-course)

Maybe, a more frustrating experience for the EEP students was that they felt incompetent in English language skills as clarified below.

“Initially, preparing a PBL project seemed frightening to me. Despite completing a one-year English language program, I have not been able to improve my reading, writing, and listening skills. Despite language-related difficulties, I believe that we will be able to complete this project successfully. It will be useful for improving my English since the project is totally run in English.” (EEP-Student6/pre-course)

A few students from both groups drew attention to the allocated time for the project, and one of the ELT students in the following excerpt explained the reason behind the time constraint.

“Our topic requires us to spend much time at school. The only solution is working in a group. If I were working alone, I would not have enough time to study.” (ELT-Student54/pre-course)

Moreover, students had to cope with the feeling of uncertainty at the beginning. Welcoming divergent ideas caused uneasiness for a few although differences were appreciated for the majority. These two initial difficulties were noted in the following excerpt.

“...we’re having difficulty coming to an agreement on certain issues in our group. For example, we are still not sure about the title of our project. I am not sure whether we will complete the project or not.” (EEP-Student10/pre-course)

#### **Theme 6: Favorable and unfavorable aspects of PBL**

The most positive aspect was that both groups of students had the opportunity to acquire knowledge about the subject investigated; in other words, the majority sincerely liked expanding their knowledge as is obvious in the following excerpt.

“The thing I liked the most about this project is that I learned about what knowledge an engineer should have.” (EEP-Student64/post-course)

Another common favorable aspect of PBL was the improvement in time management skills. Students attributed this improvement to the use of planning sheets, diaries and working in groups. One student stated that one of the best aspects of the course was being able to plan and reflect on his work and achievements on a regular basis. More specifically, the majority of the ELT students seemed to like working in groups, taking responsibility, conducting research, presenting the projects in front of their peers and witnessing the realities of their country. One ELT student as seen in the following excerpt expressed this.

“What I liked the most was to gain awareness of the realities of my country. While doing this research, I saw that there were children, young people whose parents were divorced and had financial problems...”  
(ELT-Student1/post-course)

As for what they liked the least, a few difficulties related to group work and some minor research-related issues were addressed. The prominent unfavorable aspect for the EEP students was that they did not like being obliged to cope with the disagreements in the group. In sum, it is clear that the favorable aspects outnumbered the unfavorable aspects.

Apart from open-ended questionnaire results, the examination of reflection reports also provided valuable data. The reflections revealed two main themes as “ingredients of PBL and PBL as a learning journey”. The figure below picturizes the four ingredients of PBL, which are authentic work, work relevant to the real world, tutorials and divergent ideas:

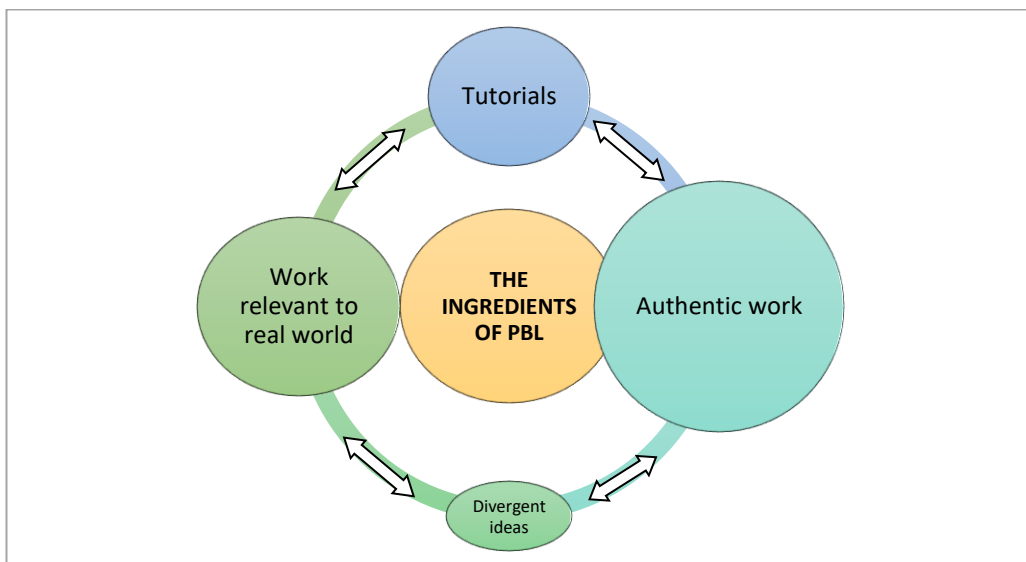


Figure 2. Conceptualizations regarding the ingredients of PBL.

In Figure 2, the size of the circles indicates the level of importance attributed to each sub-theme. Besides, each sub-theme is intertwined with each other from the students' point of view. To clarify, students from both groups believed that their PBL projects were considerably authentic and relevant to the work that they would be involved in during their daily lives. The excerpt below is evidence for this.

“Cooling systems are produced to make these electronic goods work better. Because of that reason, all electronic machines that we use at home should have an effective cooling system to work perfectly well. We have decided to search on this important topic.” (EEP-Student59)



ELT students also felt the necessity to solve a real-life problem. This is because it would help them use this PBL skill in their future teachings as indicated in the excerpt below.

“I think it is also a part of our routine life. We always face problems, and we get over them by choosing the best solution... Therefore, doing a PBL project is the same as real life itself. To be successful, we need to do nothing but take it seriously.” (ELT-Student37)

The remaining ingredients are the ones which were less frequently emphasized by the two groups of students. The first one is the emergence of divergent ideas during group work and the second one is the effectiveness of the tutorials as a learning platform. Many students appreciated the existence of divergent ideas although some others did not welcome it. The following excerpts exemplify these different opinions.

“Before starting the project, we reviewed some articles, and everybody found different solutions. While doing so, our friendship has become stronger. I feel better as a person who is contributing to the problem-solving process.” (ELT-Student22)

“In the group, we learn new ideas from each other. But sometimes there are some disagreements which may have some bad effects on our motivation.” (EEP-Student33)

In relation to tutorials, especially the EEP students indicated that they had efficient learning experiences thanks to the tutorials. Both groups of students regarded the tutorials as a significant learning environment for the reason that they considered fellowship in the groups to be of great value to themselves. They also used the group as an instrument for tuning their own understanding of concepts and strategies for problem-solving. A student expressed this as follows.

“Tutorials are quite new to me. It is enjoyable but sometimes ideas clash and it becomes difficult to reach consensus. Secondly, it is a big pressure since you are responsible not only to yourself but also to your friends. However, those difficulties and pressures made us feel stronger as long as we produced more fruitful ideas.” (EEP-Student7)

The second main theme, which is “PBL as a learning journey”, is illustrated in Figure 3:

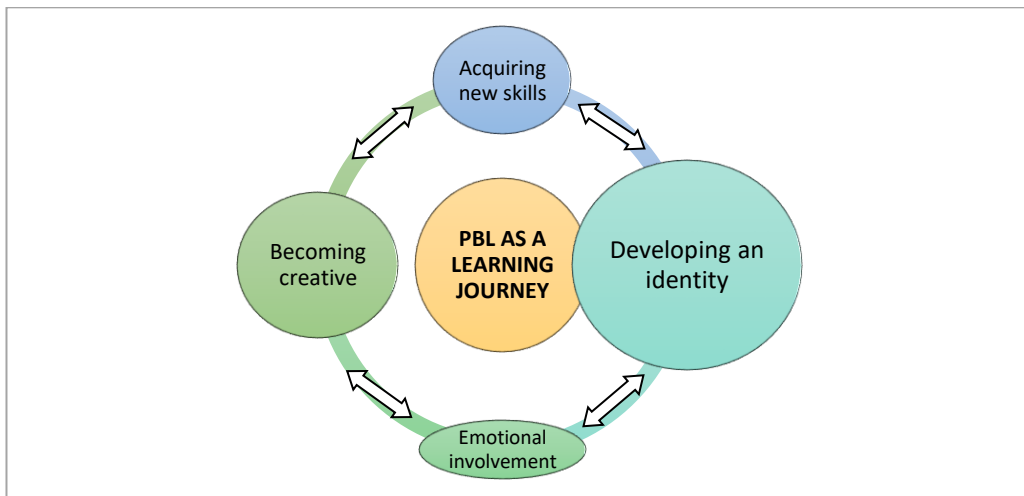


Figure 3. The PBL journey.

Figure 3 clearly shows that, just as in Figure 2, the sub-themes in the bigger circles represent the ideas, which were more frequently mentioned by the two groups of students. The focal point of Figure 3 is that each sub-theme is a part of the PBL journey and interrelated. That is, PBL is considered a journey in which students develop a new identity, become more creative, acquire new skills and are emotionally involved in rich learning experiences. The realization of PBL as a journey is obvious in the following excerpt.

“This project will consolidate my English. I know that I am at the beginning of this road and if I could get a good start, I think that the rest will follow perfectly.” (ELT-Student49)

As for crucial parts of this PBL journey, students reported that they gained a new identity not only as being university students but also as prospective professionals. They developed self-confidence and more positive feelings toward their profession and their peers. Moreover, students discovered their creativity and potential. The relevant excerpts about identity development and creativity are presented below.

“This project made me feel important in the sense that I and my friends could be a real hero and heroine who were equipped with unique skills and original ideas.” (ELT-Student2)

“This is an opportunity for us to reveal our thoughts and use our creativity. However, in some other projects, information is only based on what we read in the texts or what we get from the Internet. This one is different because it forces us to think over problems with the aim of finding original and creative solutions.” (EEP-Student13)

The last two sub-themes, which are acquiring new skills and emotional involvement, pinpoint that the students from both groups acquired new skills through trial and error. In addition, different from other courses they took, they were not only involved in projects with their academic knowledge but also with their personality, feelings, attitudes, or visions. All these are evident in the following excerpt.

“I like doing these kinds of projects... In my opinion, bringing your potential into life, learning new things, and developing your skills with your whole body and soul are only possible if you participate in such projects.” (EEP-Student60)

## Discussion, conclusions and suggestions

Findings indicate that PBL is an approach that might better prepare students for the world of teaching and engineering by aligning curriculum delivery with existing undergraduate programs. This trial has been an encouraging first attempt in an ELT context and a novel method for the instruction in a Technical English course designed for EEP students. Though it was the first time for the participants of the current study to be engaged in a PBL project, they easily became familiar with the primary tenets of PBL, and they were good at differentiating between the implications of PBL curricula and other courses taught in traditional methods, which only or dominantly supported the transfer of theoretical knowledge. Among the tenets identified by the ELT and EEP students, the most prominent ones are authenticity, independence, responsibility, conflict management, teamwork and research skills. Depending on these, such PBL applications provide academically, personally and emotionally richer learning experiences because they enhance the skills of questioning, obtaining information, thinking critically, learning to learn and self-efficacy (Hatisaru, 2018). This finding is also evident in the students' utterances indicating that PBL is considerably different and beneficial to a degree that its philosophy should be applied in other courses offered in their departments. Another important reason for the inclusion of PBL tenets into the field of education and engineering might be the need, as Budaghyan (2015) proposes, for well-designed training where students become autonomous, cooperative, active participants of the learning process, and talented problem-solvers.

It is clear that both ELT and EEP students had similar perceptions and experiences throughout the projects. This is evident in the identical conclusions drawn from the comparisons of the initial and final perceptions and experiences and from the commonalities between the findings of the questionnaires and

reflection reports. Those similarities were mainly linked to the benefits, characteristic features, and favorable aspects of PBL along with positive feelings toward PBL. Herein, the most prominent finding is that the EEP students anticipated fewer benefits in relation to PBL; yet, at the end of the process, they proposed benefits that are more varied. This may indicate that the EEP students' perceptions in the initial and final stages of PBL differ more widely. Compared to all these positive perceptions and experiences, negative aspects or feelings as well as difficulties in relation to PBL were fewer in number. These positive attitudes toward PBL signify that teacher knowledge and skills can be developed through authentic scenarios, group collaborations and self-directed learning (Borhan, 2014); and engineer candidates could be suitably prepared for their careers (Kolmos & DeGraaff, 2014) thanks to a PBL-oriented curriculum. Bijzak (2008) also argued similar positive attitudes of EEP students as well as the faculty members toward PBL.

Specifically, for how our PBL implementation in the ELT and EEP differ from each other, it should be noted that the slight differences might be derived from the educational contexts of the two cases. That is, both the content and the medium of instruction is English for the ELT case whereas the EEP case struggles to learn a technical content in a foreign language. This disparity is reflected in a number of findings. For instance, the ELT students reported more benefits in relation to the improvement of their research skills during the PBL project. Yet, the EEP students paid much of their attention to the improvement of foreign language skills through PBL. In a similar vein, the EEP students faced language-related troubles, unlike the ELT students. As a solution, the EEP students might be encouraged or taught to reflect on their progress and learning outcomes (Gratchev & Jeng, 2018), particularly for language-related challenges before or during the PBL procedure. The common troubles, which resulted in unfavorable PBL experiences, were mainly disagreements in the group, divergent ideas in the tutorials and conducting quality research. In spite of these negative perceptions and experiences, the participants regarded some of those as crucial parts of their PBL experience (see Figure 2). Moreover, the PBL journey of the participants (see Figure 3) led to an identity change, which was accompanied by emotional involvement, creativity and acquiring new skills. Although these are considered as separate concepts, it may be argued that these three concepts constitute the identity changes. Namely, it would be better to acknowledge the concept of identity change as an umbrella term explaining the whole PBL journey. It was not highlighted by the participants, but the ability to self-direct is essential for the quality of learning through PBL (Kırkgöz & Turhan, 2021), and may be an important factor for a smooth identity development process. There are still some blank spaces in the implementation of PBL (Major & Mulvihill, 2018), and being self-directed is a blank space in this study. Finally, yet importantly for the differences, the ELT students provide

hints about their broader perspective toward the educational realities of Türkiye (see Theme 6) as a result of engaging in the PBL project. Similarly, some previous studies propose that PBL has the potential to illuminate the student teachers' diverse perspectives (e.g. Kırkgöz, 2017; 2018). Evidently, some significantly different perceptions and experiences in relation to PBL were explored despite the fact that the participants' similar perceptions and experiences dominated the entire set of findings. Thus, we can support the argument that our PBL procedures have comparable characteristics. We should honestly admit that we might reach identical results if we scrutinized only one of the cases. Nevertheless, examining the two cases provided an inspiration about how we could tailor a PBL-oriented curriculum in light of the predictions of similar and contrasting results across the cases.

The study offers implications for those who are experiencing difficulties with implementing problem-based curricula, and those who are designing problem-based models. Especially for teachers and engineering education, the findings of this study could be inspiring. It is the student-oriented activities based on the PBL philosophy (Anderson, 2005), which provide inspiration for educators to design and apply a PBL-oriented curriculum. The participants of this study noted that their previous education had not prepared them for interactive, student-oriented practices and PBL. Thus, guidance and support provided by the educators might be more essential so that students could experience a smoother transition in their first problem-based learning experience. This is also vital to deal with and minimize the inefficacious aspects of traditional learning approaches in which theoretical knowledge was dominant. If there is no guidance or support in the format of scaffolding during PBL, then students may be confronted with frustration (Yadav, 2006), which most probably leads to a loss of motivation toward PBL. Such negative feelings (e.g. worry, anxiety, and nervousness) were also detected in our participants; however, certain positive feelings (e.g. satisfaction, pride, confidence) were evident and increased toward the end of the projects. Another implication is linked to the theory and practice dilemma. In teacher education contexts, teacher candidates face difficulties in putting their theoretical knowledge into practice (Kırkgöz, 2015; Pourshafie & Murray-Harvey, 2013; Kırkgöz & Turhan, 2021) because of traditional training methods (Özçınar & Deryakulu, 2011); and besides, Turkish teacher trainees could only apply theory in a limited teaching environment just like argued by Hennissen et al. (2017), who found out that theory is included in primary school teacher training but is not embedded in teaching practices. As for engineering, PBL has proven itself as a method, which creates strong educational results (Mann et al., 2021); nevertheless, its outcomes should be unpacked in engineering courses where the medium of instruction is not the native language of the students just as in this study. This is highly crucial since theoretical knowledge learnt through a foreign or second language has to be put into

practice in real engineering settings; yet, unfortunately, prospective engineers have solely a few chances to do so at undergraduate level (Roach et al., 2018; Ruhizan et al., 2009).

To increase the opportunities for practice, PBL applications should be substantially incorporated into undergraduate courses. Even technology-supported teacher training courses taught through PBL, also mentioned by So and Kim (2019), may be offered so that student participation, equality and individual needs could be prioritized (Scott, 2015). Online courses are also fundamental for engineering education and have become more of an issue in the time of pandemic since 2020. The integration of online tools in PBL was found to be useful to improve critical thinking skills, as well (Hussin et al., 2019). For this reason, a further study could focus on how online or digital tools can enhance PBL experiences of students at tertiary level. We also believe that the combination of PBL and technology-supported tasks provides agency to be maximized in a specific way so that students become socially and environmentally responsible professionals who are more responsive and sensitive to future professional challenges. Depending on the positive outcomes of a PBL-oriented curriculum in two different contexts within this study, comprehensive longitudinal studies on PBL need to be conducted across disciplines. Particularly disciplines in which the medium of instruction is a foreign language should be within the scope of further PBL studies.

### Acknowledgement

The authors would like to thank the reviewers for their valuable comments and Assist. Prof. Dr. Zoe Marlowe for meticulously editing the article.

### References

- Anderson, J. R. (2005). *Cognitive Psychology and Its Implications*. New York: Worth.
- Barrows, H. S. (1980). *Problem-based learning: An approach to medical education*. Springer series on Medical Education, New York.
- Bizjak, G. (2008). Load flow network analysis with problem-based learning approach. *International Journal of Electrical Engineering Education*, 45(2), 144–151. <https://doi.org/10.7227/IJEEE.45.2.6>

- Bledsoe, K. E., & L. Flick. (2012). Concept development and meaningful problem-based laboratory experience. *Journal of Science Education and Technology*, 21(2), 226–245. <https://doi.org/10.1007/s10956-011-9303-6>
- Borhan, M. T. (2014). Problem based learning (PBL) in teacher education: A review of the effect of PBL on pre-service teachers' knowledge and skills. *European Journal of Educational Sciences*, 1(1), 76–87. <https://doi.org/10.19044/ejes.v1no1a9>
- Budaghyan, S. (2015). Technology teacher training in a remote region of Armenia. *Procedia -Social and Behavioral Sciences*, 197, 197–200. <https://doi.org/10.1016/j.sbspro.2015.07.123>
- Canavan, B. (2008). A summary of the findings from an evaluation of problem-based learning carried out at three UK universities. *International Journal of Electrical Engineering Education*, 45(2), 175–180. <https://doi.org/10.7227/IJEEE.45.2.9>
- Chen, J., Kolmos, A., & Du, X. (2021). Forms of implementation and challenges of PBL in engineering education: A review of literature. *European Journal of Engineering Education*, 46(1), 90-115. <https://doi.org/10.1080/03043797.2020.1718615>
- Dahlgren, M. A., & Dahlgren, L. O. (2002). Portraits of PBL: Students' experiences of the characteristics of problem-based learning in physiotherapy, computer engineering and psychology. *Instructional Science*, 30, 111-127. <https://doi.org/10.1023/A:1014819418051>
- de Camargo Ribeiro, L. R. (2008). Electrical engineering students evaluate problem-based learning (PBL). *International Journal of Electrical Engineering Education*, 45(2), 152–161. <https://doi.org/10.7227/IJEEE.45.2.7>
- English, M. C., & Kitsantas, A. (2013). Supporting student self-regulated learning in problem- and project based learning. *Interdisciplinary Journal of Problem-Based Learning*, 7(2), 128-150. <https://doi.org/10.7771/1541-5015.1339>
- Ferreira, M. M., & Trudel, A. R. (2012). The impact of problem-based learning (PBL) on student attitudes toward science, problem-solving skills, and sense of community in the classroom. *Journal of Classroom Interaction*, 47(1), 23-30.
- Gratchev, I., & Jeng, D. S. (2018). Introducing a project-based assignment in a traditionally taught engineering course. *European Journal of Engineering Education* 43(5), 788–799. <https://doi.org/10.1080/03043797.2018.1441264>
- Happell, B. (1991). Problem-based learning: Providing hope for psychiatric nursing? *Medical Education*, 25(2) 140-3.
- Hatisaru, V. (2015). Investigating student growth in problem based learning treatment mathematics classes. *Gaziantep University Journal of Social Sciences*, 14(2), 459–477. <https://doi.org/10.21547/jss.256769>

- Hennissen, P., Beckers, H., & Moerkerke, G. (2017). Linking practice to theory in teacher education: A growth in cognitive structures. *Teaching and Teacher Education*, 63, 314–325. <https://doi.org/10.1016/j.tate.2017.01.008>
- Hu, J., Martinez Ortiz, A., & Sriraman, V. (2014, June). *Implementing PBL in a Concrete Construction Course*. American Society for Engineering Education.
- Hussin, W. N. T. W., Harun, J., & Shukor, N. A. (2019). Problem based learning to enhance students critical thinking skill via online tools. *Asian Social Science*, 15(1), 14–23. <https://doi.org/10.5539/ass.v15n1p14>
- Jerzembek, G., & Murphy, S. (2013). A narrative review of problem-based learning with school-aged children: Implementation and outcomes. *Educational Review*, 65(2), 206-218. <https://doi.org/10.1080/00131911.2012.659655>
- Katitia, D. M. O. (2015). Teacher education preparation program for the 21st century. Which way forward for Kenya? *Journal of Education and Practice*, 6(24), 57–64.
- Kirkgöz, Y. (2015). Designing and implementing an innovative problem-based teacher education course. *American Journal of Educational Science*, 1(5), 229-239.
- Kirkgöz, Y. (2017). Working the problem: Finding solutions to student dissatisfaction in EAP for engineering. In Stewart, T. (Ed.), *TESOL voices: Insider accounts of classroom life higher education* (pp.17-26). Alexandria, Va: TESOL Press.
- Kirkgöz, Y. (2018). Problem-based learning in a teacher education program: A study of learning outcomes. In Genç, Z. S. (Ed.), *Updating perspectives on English language teaching and teacher education* (pp 79- 92). Peter Lang.
- Kirkgöz, Y., & Turhan, B. (2021). Views of Turkish EFL teacher trainees toward technology-integrated PBL practices. *English Language Teaching Educational Journal*, 4(1), 74-86. <https://doi.org/10.12928/eltej.v4i1.3748>
- Kolmos, A., & DeGraaff, E. (2014). Problem-based and Project-based learning in engineering education: Merging models. In A. Johri & B. M. Olds (Eds), *Cambridge Handbook of Engineering Education Research (CHEER)* (pp. 141–160). New York: Cambridge University Press. <https://doi.org/10.1017/CBO9781139013451.012>
- Lutsenko, G. (2018). Case study of a problem-based learning course of project management for senior engineering students. *European Journal of Engineering Education*, 43(6), 895–910. <https://doi.org/10.1080/03043797.2018.1454892>
- Major, T., & Mulvihill, T. M. (2018). Problem-based learning pedagogies in teacher education: The case of Botswana. *Interdisciplinary Journal of Problem-Based Learning*, 12(1). <https://doi.org/10.7771/1541-5015.1543>
- Mann, L., Chang, R., Chandrasekaran, S., Coddington, A., Daniel, S., Cook, E., & Smith, T. D. (2021). From problem-based learning to practice-based



- education: A framework for shaping future engineers. *European Journal of Engineering Education*, 46(1), 27-47.  
<https://doi.org/10.1080/03043797.2019.1708867>
- McQuade, R., Wiggins, S., Ventura-Medina, E., & Anderson, T. (2018). Knowledge disagreement formulations in problem-based learning tutorials: Balancing pedagogical demands with saving face. *Classroom Discourse*, 9(3), 227–243. <https://doi.org/10.1080/19463014.2018.1495089>
- Özçınar, H., & Deryakulu, D. (2011). The effects of reflection points in video-cases and teacher participation in online discussion groups on reflective thinking. *Hacettepe University Journal of Education*, 40, 321–331.
- Palmer, S., & Hall, W. (2011). An evaluation of a project-based learning initiative in engineering education. *European Journal of Engineering Education*, 36(4), 357–365. <https://doi.org/10.1080/03043797.2011.593095>
- Pourshafie, T., & Murray-Harvey, R. (2013). Facilitating problem-based learning in teacher education: Getting the challenge right. *Journal of Education for Teaching*, 39(2), 169-180.  
<https://doi.org/10.1080/02607476.2013.765190>
- Qattawi, A., Venhovens, P., & Brooks, J. (2014). Rethinking automotive engineering education: Deep orange as a collaborative innovation framework for project-based learning incorporating real-world case studies. In *Proceeding of 121st ASEE Annual Conference & Exposition* (pp. 1–28). Indiana: ASEE Prism.
- Roach, K., Tilley, E., & Mitchell, J. (2018). How authentic does authentic learning have to be? *Higher Education Pedagogies*, 3(1), 495–509.  
<https://doi.org/10.1080/23752696.2018.1462099>
- Ruhizan, M. Y., Ramlee, M. & Azami, Z. (2009). Promoting creativity through problem-oriented project-based learning in engineering education at Malaysian Polytechnics. In *Proceedings of the 8th WSEAS International Conference*. <https://www.semanticscholar.org/paper/Promoting-creativity-through-problem-oriented-based-Yasin-Mustapha/ff0c46b67809111cc7dd26b52170141bb3576417>
- Said, S. M., Adikan, F. M., Mekhilef, S., & Rahim, N. A. (2005). Implementation of the problem-based learning approach in the department of electrical engineering, University of Malaya. *European Journal of Engineering Education*, 30(1), 129-136. <https://doi.org/10.1080/03043790512331313895>
- Scott, C. L. (2015). *The futures of learning 3: What kind of pedagogies for the 21st century?* UNESCO Education Research and Foresight, Paris. ERF working papers series, no. 15.
- So, H. J., & Kim, B. (2009). Learning about problem based learning: Student teachers integrating technology, pedagogy and content knowledge. *Australasian Journal of Educational Technology*, 25(1), 101-116.  
<https://doi.org/10.14742/ajet.1183>

- Strobel, J., & van Barneveld, A. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdisciplinary Journal of Problem-Based Learning*, 3(1), 44-58.  
<https://doi.org/10.7771/1541-5015.1046>
- Tan, C. P., Van der Molen, H. T., & Schmidt, H. G. (2016). To what extent does problem-based learning contribute to students' professional identity development? *Teaching and Teacher Education*, 54, 54-64.  
<https://doi.org/10.1016/j.tate.2015.11.009>
- Tarman, B. (2010). Global perspectives and challenges on teacher education in Turkey. *International Journal of Arts and Sciences*, 3(17), 78-96.
- Thomas, R. E. (1997). Problem-Based Learning: Measurable Outcomes. *Medical Education*, 31(5), 320-329. <https://doi.org/10.1046/j.1365-2923.1997.00671.x>
- Yadav, A. (2006). *Video cases in teacher education: What role does task play in learning from video cases in two elementary education literacy methods courses?* (Doctoral dissertation, Michigan State University). East Lansing, MI.
- Yadav, A., Subedi, D., Lundeberg, M. A., & Bunting, C. F. (2011). Problem-based learning: Influence on students' learning in an electrical engineering course. *Journal of Engineering Education*, 100(2), 253-280.  
<https://doi.org/10.1002/j.2168-9830.2011.tb00013.x>
- Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage.