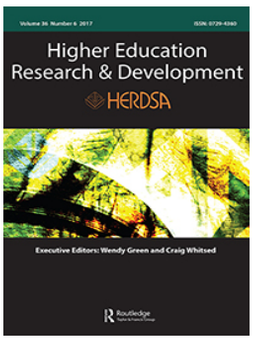

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PBL in teacher education: its effects on achievement and self-regulation

Tolga Erdogan[a] and Nuray Senemoglu[b]

[a]Foreign Languages Department, Army NCO Vocational College, Balikesir, Turkey; [b]Faculty of Education, Hacettepe University, Ankara, Turkey

ABSTRACT

Problem-based learning (PBL) as an educational practice continues to have great impact on all levels of education and across different disciplines. The aim of this experimental study is to examine the effects of PBL on prospective teachers' academic achievements and self-regulation. The treatment group ($n = 36$) and the control group ($n = 21$) comprised Middle East Technical University Language Teaching Department senior students attending the Language Testing and Evaluation Course. Quantitative data were collected via an achievement test, an open-ended application exam and a scale on self-regulation in learning. Qualitative data were obtained through student interviews. The quantitative results revealed that PBL was effective for students' knowledge, comprehension and application-level achievements, but it had no significant effects on their self-regulation. The content analysis of student interviews yielded some positive findings about the application of PBL in teacher education, its strengths and weaknesses as experienced during implementation, together with individual and group work processes involved. The study offers some suggestions for the application of PBL in large classes generally and specifically in a teacher education course.

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Achievement; language testing and evaluation; problem-based learning; self-regulation; teacher education

Introduction

Problem-based learning (PBL) is a student-centered approach, which has its roots in constructivist epistemology (Savery & Duffy, 1995). It begins with the introduction of an ill-structured problem, where teachers act as facilitators and learners actively construct knowledge by defining learning goals, seeking information to build upon prior knowledge, reflecting on the learning process and participating actively in cooperative/collaborative learning groups (Barrows, 1996, 1998; Hmelo-Silver, 2004). Among the educational objectives listed by Barrows (1986), PBL's promotion of learning outcomes in the cognitive, affective and conative domains (Huitt & Cain, 2005; Leary, 2012) are implied. In other words, PBL is thought to have the potential to promote not only what is learned, but also to emphasize the affective traits about what is learned and the learning experience itself, together with the willingness and desire to learn.

CONTACT Tolga Erdogan tolgasensei@gmail.com

A review of the PBL literature shows that the majority of research and practice has been undertaken in higher education, specifically medical education. But recently more research has been done in different disciplines and at different levels (Savery, 2006; Walker & Leary, 2009). Several meta-analyses and reviews (Albanese & Mitchell, 1993; Berkson, 1993; Colliver, 2000; Dochy, Segers, Van den Bossche, & Gijbels, 2003; Gijbels, Dochy, Van den Bossche, & Segers, 2005; Kalaian, Mullan, & Kasim, 1999; Leary, 2012; Loyens, Magda, & Rikers, 2008; Üstün, 2012; Vernon & Blake, 1993; Walker & Leary, 2009) have analyzed the effectiveness of PBL. However, as Strobel and van Barneveld (2009) put forward, more studies are needed to analyze PBL's appropriateness, its application and practices, its strengths and weaknesses, and its potential influence on today's education.

Some concerns have been reported that students might not have equal educational development or that there would be no controlled learning during PBL sessions. Albanese and Mitchell (1993) argued that PBL students scored lower on basic science examinations in comparison with their conventionally trained counterparts. Similarly Kalaian et al. (1999) indicated that PBL students had higher performance on standardized profession-wide clinical science outcome measures, but lower on basic science outcome measures. On the other hand, in their review of PBL research beyond the domain of medical education, Dochy et al. (2003) found not only that PBL had significant positive effects on knowledge application, but also that students in PBL performed at least as well as conventional students in basic knowledge. In his review, Colliver (2000) found no convincing evidence of PBL improving students' knowledge base or clinical performance. Nevertheless, he stated that PBL might provide a more challenging, motivating and enjoyable approach to medical education. As can be seen, a brief review of the literature shows mixed results about PBL's influence on knowledge base and application. There is a need to elaborate further PBL's influence at all cognitive levels, starting from levels of knowledge and comprehension to application and those levels above.

Apart from PBL's effect on cognitive levels, some studies have found positive results concerning PBL's influence on the development of self-regulation and motivational elements. Meta-analyses by Leary (2012) and Blumberg (2000) and other research (Galand, Bentein, Bourgeois, & Frenay, 2005; Kivela & Kivela, 2005) suggested a positive contribution of PBL to students' self-directed learning (SDL) or self-regulated learning (SRL) skills. Hmelo and Lin (2000) observed an increase in PBL students' SDL skills as a result of usage of more resource material, exposure to more online and offline material, integration of that material into their course studies, et cetera. Sungur and Tekkaya (2006) suggested that, in terms of self-regulation, PBL students had a higher level of task value, metacognitive self-regulation and intrinsic goal orientation and they concluded that those students were better in organizing their efforts, critical thinking and learning from their peers. In their quasi-experimental research study, Walker and Lofton (2003) found that all subjects experienced a significant decline in their perceived importance of SDL as a result of a PBL curriculum. Turan (2009) found a medium level relationship among students' attitudes toward PBL, their metacognitive and SDL skills and suggested the need for student-centered instruction in the development of such conative elements. In their review of empirical studies, Loyens et al. (2008) found some evidence on PBL's positive influence, though the studies they focused on showed mixed results. They also

reported the need of more research to better understand how, when and why PBL would foster development of SDL or SRL.

There is also a body of evidence derived from interviews and observations in related research on PBL. In summary, it is suggested that PBL grants students the chance to work on real-life problems in their cooperative learning groups and supports student development by enhancing sharing of knowledge (Gibbings, Lidstone, & Bruce, 2015; Kumar & Kogut, 2006; Van der Heyde, 2009); PBL is well received and found useful both by the instructors and students (Elsie, Francis, & Gonzaga, 2009; Kivela & Kivela, 2005; Pepper, 2010); PBL enhances the development of SRL skills of students better than their counterparts receiving traditional instruction (Downing, Kwong, Chan, Lam, & Downing, 2009); the interactions among students in PBL tutorials contribute substantially to group processes and performance outcomes (Das Carlo, Swadi, & Mpofu, 2003; Dolmans, Wolfhagen, & Van der Vleuten, 1998; Rissi, 2010); the ultimate gains of PBL classes are interaction and access to more information as a result of increased research skills (Rissi, 2010); PBL students' reliance on their instructors' guidance decreases and they focus more on their peers' opinions and contributions (Kivela & Kivela, 2005); and PBL is influential in the development of group interactions, student self-reliance, research skill development and active participation during the learning process (Dickie & Jay, 2010). On the other hand, the workload of PBL tutorials is a common complaint among students and students' statements of uncertainty (what to learn, where to find, how to start, etc.) at the beginning of PBL tutorials are some of the challenges noticed (Galand et al., 2005; Kivela & Kivela, 2005).

The prior meta-analyses, reviews and studies summarized above clearly suggest that PBL studies mainly have focused on cognitive outcomes and there is lack of research concerning affective and conative outcomes of PBL instruction. Nevertheless, in these analyses, PBL students seem to perform better than those students with traditional training in knowledge principles and application, problem-solving and SDL/SRL, whereas traditional students' performance in basic knowledge is mostly better than PBL students.

Finally, as Savery (2006) and Walker and Leary (2009) pointed out the popularity of PBL in other disciplines and subjects apart from medical education, research on PBL in teacher education not only would increase the variety of input about PBL's utilization in different areas, but also would provide teacher candidates with an example which they could use as a model in their future classroom practices. During the four-year teacher education programs in colleges of education in Turkey, which were restructured in 1997 and slightly revised in 2007 (Yükseköğretim Kurulu, 2007), prospective teachers have various courses such as teaching profession courses (e.g., pedagogical theories and their implications), branch or area courses (e.g., language teaching, mathematics, history) and general knowledge/culture courses (e.g., literature, history, most of which are electives). The teaching practice, together with teaching practice courses, is undertaken in the senior year. As Yeo (2015) explains, 'anchoring pre-service teacher's learning in authentic problem solving can support them in making linkages between pedagogical theories and classroom practices.' And Yeo states that this theory–practice nexus should not be left to the teaching practicum which often takes place at the end of the teacher education program. The authors believe that PBL has the power to provide such linkage between theory and practice.

In this respect, the aim of this study is to analyze PBL's influence on students' academic achievements and their self-regulation and to review students' opinions on PBL considering its promises and challenges, strengths and weaknesses in teacher education. The research questions addressed by this paper include:

(1) Is there a significant difference between achievement levels of students in treatment (PBL) and control (conventional) groups?
(2) Is there a significant difference between the self-regulation levels of students in both treatment and control groups?
(3) What do the students think about the implementation of PBL?

Building on the above research, the authors' purpose is not an attempt to replicate the findings obtained in previous studies, but to examine the possible influence of PBL on different achievement levels, from knowledge to application and at the same time to address the call for research concerning PBL's influence on conative elements like SRL. The final aim is to learn what students think about the PBL experience that may guide future practitioners in their PBL journey and to discuss the use of PBL in teacher education.

Method

Methodology and participants

In this experimental research with control group pre–post test design, the participants were Middle East Technical University (METU) English Language Teaching Department senior undergraduate students taking the language testing and evaluation course in their senior year. The testing and evaluation course is a compulsory one-semester study generally taken by senior students majoring in various departments of colleges of education. The course is already overloaded with topics such as theory of assessment, types of assessment, test preparation techniques, testing various skills, analysis techniques and statistical calculations. According to Uzun (2016), it is one of the crucial courses highly rated by language teacher candidates as a course contributing both to their professional and personal developments.

There were 36 students in the treatment group and 21 in the control group. The students were assigned to each group depending solely on their preferences during course registrations and they were not informed that they would be part of an experiment. Ethics approval was granted by the university's Board of Ethics. Conventional methods were used in the control group, where the instructor lectured most of the time, gave some pre-reading assignments and managed small class discussions in class, whereas the lessons in the treatment group were implemented according to the principles of PBL methodology by an instructor who had good knowledge of and experience in constructivist teaching. The instructor took the lead in the control group as the sole knowledge provider and coordinator, whereas in the treatment group, in the absence of a regular tutor for each cooperative learning group, the instructor took the role of a 'floating tutor' (Duch, 2001, pp. 40–41) and facilitated students' efforts in their group work during class sessions. Taking the objectives of the course into account, modules were designed and used during

PBL tutorials in the treatment group. There were a total of four modules, which focused on different aspects of language testing and evaluation. The instructor literally 'floated around' the tutorial groups during class hours in order to help students define their problems, identify the mechanisms for each problem, work on alternative solutions, test their solution(s) and reach a conclusion or repeat the cycle if the resulting solution(s) was/were not satisfactory. The students in the treatment group arranged the time and place for their after-class meetings. The members of cooperative learning groups designated a group leader interchangeably for each module and those assigned leaders coordinated the group work outside classes and took the lead during presentations of their findings in class. At the end of each module, the designated speakers from each group presented their group's arguments and findings were elaborated as a whole class activity.

The data collection instruments were utilized prior to and following the 15-week treatment in both groups. Apart from the control group, 14 students, two from each cooperative learning group in the treatment group, were interviewed on completion of the treatment, immediately after the final applications of achievement tests and the scale on self-regulation.

Instrumentation and data analysis

Achievement tests (a multiple-choice knowledge and comprehension test and an open-ended application exam), a scale on self-regulation in learning and a semi-structured interview form were developed by the researchers and used to gather the qualitative and quantitative data.

The multiple-choice achievement test consists of 35 items (15 knowledge level and 20 comprehension level items) and has the Cronbach's alpha value of 0.91. The open-ended application exam aims to assess behaviors at application and higher levels.

The 'scale on self-regulation in learning' (SSRL) developed for this research is based on a literature review and similar studies. The scales and inventories utilized are the Self-Regulatory Learning Inventory of Lindner, Harris, and Gordon (1996), the Motivational Strategies for Learning Questionnaire of Pintrich and De Groot (1990), the Self-Regulatory Learning Interview Schedule of Zimmerman and Martinez-Pons (1986) and the Self-Regulated Learning Skill Inventory of Heo (1998). In short, the 67-item scale, which has two sub-scales as SRL skills/strategies and motivation, has a Cronbach's alpha of 0.91 for the whole scale. Confirmatory factor analysis was used to provide further validation for the scale. The goodness-of-fit indices obtained for the whole scale showed that the model had either perfect or acceptable fit values as suggested by Hair, Black, Babin, and Anderson (2010) and Schermelleh-Engel, Moosbrugger, and Müller (2003, p. 52).

During analyses, descriptive statistics, ANOVA for repeated measures and independent samples *t*-test were utilized to analyze quantitative data, by using SPSS, whereas content analysis was used to analyze the qualitative data.

Findings and results

Research Question 1: Is there a significant difference between achievement levels of students in control (conventional) and treatment (PBL) groups?

In order to get a better picture of PBL's influence on cognition, achievements of students in both groups were investigated at knowledge, comprehension and application levels. For this purpose, the achievement test was administered to both control and treatment groups as a pre-test and post-test, whereas the application exam was administered as a post-test only.

The means and standard deviations for the pre–post test applications of the knowledge part of the achievement test for both treatment and control groups are given in Table 1. It is clear that gains in PBL students' knowledge test scores (+6.27) were higher than those of conventional students (+5.10). However, repeated measures of variance revealed that PBL produced no significant difference in knowledge level over the course of study, $F(9.27, 161.52) = 3.11$, $p > .05$. In other words, the students in treatment and control groups performed almost similarly on the knowledge part of the achievement test.

The means and standard deviations for the pre–post test applications of the comprehension part of the achievement test are given in Table 2. Repeated measures of variance revealed that PBL produced a significant difference in comprehension level over the course of study, $F(244.14, 144.39) = 93$, $p < .01$. In other words, the students in the treatment group performed better than the students in the control group on the comprehension part of the achievement test. The pairwise comparisons of both groups' scores showed that the difference is in favor of the treatment group. It was concluded that PBL had a strong effect ($N^2 = 0.63$) on comprehension level achievements.

Finally, the scores students achieved in the application exam were investigated. The papers of students in both groups were scored by the course instructors and the researcher. By averaging the grading of both assessors the final scores were determined. The comparison of application exam scores of students in the treatment group ($M = 16.36$, SD = 1.44) and those in the control group ($M = 11.57$, SD = 1.66) revealed significant differences between the groups ($t_{(55)}=11.46$, $p < .05$). This finding can be interpreted as PBL's positive influence on students' cognitive level of application.

Research Question 2: Is there a significant difference between the self-regulation levels of students in both control and treatment groups?

The means and standard deviations for the pre–post test applications of the SSRL for both treatment and control groups are given in Table 3. It is clear that gains in PBL students' scale scores (+15.28) were higher than those of conventional students (+4.27). However, a repeated measures of variance revealed that PBL produced no significant difference on self-regulation over 15 weeks, $F(754.40, 50{,}539.45) = 0.79$, $p > .05$.

Taking all dimensions in the SRL skills and motivation sub-scales into account, obviously no significant difference was observed in either group. While positive differences were found between the pre- and post-test results of students in the treatment group in all dimensions, in some dimensions (goal orientations and task value) the scores of students in the control group fell slightly.

Table 1. Descriptive statistics for pre–post test applications of knowledge test.

Groups	Tests	*n*	$\bar{X}/15$	sd
Treatment	Pre-test	36	5.31	2.45
	Post-test	36	11.58	1.87
Control	Pre-test	21	5.76	1.73
	Post-test	21	10.86	1.53

Table 2. Descriptive statistics for pre–post test applications of comprehension test.

Groups	Tests	*N*	$\bar{X}/20$	sd
Treatment	Pre-test	36	2.14	1.33
	Post-test	36	12.11	2.09
Control	Pre-test	21	2.48	1.17
	Post-test	21	6.38	1.72

Table 3. Descriptive statistics for pre–post test applications of scale on self-regulation.

Groups	Tests	*n*	$\bar{X}/335$	sd
Treatment	Pre-test	36	222.28	22.93
	Post-test	36	237.56	22.02
Control	Pre-test	19	222.26	34.93
	Post-test	19	226.53	44.32

Research Question 3: What do the students think about the implementation of PBL?

To find out what students think about PBL, 14 participants from the treatment group were interviewed and content analysis was applied to the data gathered. Five themes were conceptualized: (a) general views on PBL, (b) views on classroom applications, (c) views on group processes, (d) views on SRL and (e) suggestions about PBL. Subsequently, these conceptualized themes were supported by quotes from student interviews (shown as S1, S2, …).

The students' general views on PBL show that having the opportunity to implement what has been learned together with sharing different opinions during group work are highly favored. Working on real-life problems in their learning groups gave students a chance to practice what they had learnt. Additionally, students could express their differing opinions freely in groups and in return this led to more creativity and production:

> We had a lot of opportunity to practice. We finished the theoretical part early and had more time to implement what we have learned. We learned the necessary theoretical parts, though we didn't have to go into detail and cover all the stuff. Actually we learned and practiced what we'll use in the future. (S12)

> Since we worked on real life problems, we learned more real solutions. Sure it will help us in the future. (S2)

As for classroom application, the student views show that the number of group members in the learning groups had a negative effect on their studies, especially on their group meetings. Having more students in the groups rather than the desired number of three to four (as expressed by students) and the necessity of meeting outside of class several times a week were seen as challenging by the students. Having other courses in their last year and not enough time to carry out the heavy workload of this course made things worse. At the same time, students reported a little confusion or uncertainty in the beginning; they did not know what to do and they expressed the need to have a guide or a tutor to assist them in their group work. The crowded and noisy classrooms added to this challenge as well:

> … with less people … not six or seven … maybe three … maybe four. (S10)

> Since the very beginning we didn't know what to do, we were confused … but eventually we learn the things [*sic*] during the process. (S6)

> … A lot of noise in the classrooms. (S1)

When asked about the group process during tutorials, students stressed the characteristics of group leaders and the responsibilities of group members. The group leaders, according to students, should have patience and good communicative skills and should be open to different ideas and contributions. Also, being a member of a learning group in PBL, as in all other cooperative learning environments, necessitates sharing group responsibilities and, in addition to individual studies, being responsible for the learning levels of other group members:

> The group leader should be a person with the most patience, open to every idea and the one who can listen to others with no shouting. (S4)

> You are responsible for the learning of other people in your group, if they don't learn, it hinders your learning too. (S8)

As stated by the students, the success of group work definitely rests upon the individual work of group members, where self-regulation stands as an important aspect. The students also claimed that their critical thinking skills developed and their self-confidence improved greatly during their studies. Moreover, the students had access to more and varied forms of sources, which they said improved their research skills. The students' interaction with each other and their intra-group support for the sake of group success made it necessary for every individual to focus on their learning:

> The important thing is we learned how to criticize. (S8)

> In our previous project or group works the purpose was this: finish the tasks according to criteria and get a good grade. But here the purpose was learning. Because you can't finish the project if you don't learn. That's something different. We focused on learning … (S5)

Students presented some suggestions for future use of PBL. Considering the heavy load of the course, the students suggested it should be a one-year course, instead of one semester. The need for an external tutor or an expert in their group work was one of the demands of students together with a need for a better structuring of group processes. Having a tutor to guide the group processes would definitely help students to better organize their group work or share responsibilities. The dynamics or formations of each group were important for the success of the groups. Not every group successfully managed the heavy load, which is why some students expressed their concerns on these issues. Working as a team requires more skills than working individually, but has better results. Having a lot of work, finishing a lot of tasks in a short time, in a class with a lot of students and noise is thought to be the reason for such concerns:

> This course should be processed this way. But the only problem is the workload. If this course was a one-year long course, it would be better. (S8)

> We needed better 'instructions'. We were confused in the beginning. We didn't know what to do. (S14)

Discussion

This study aimed to investigate the effect of PBL methodology on students' achievements and on their self-regulation. To better reflect the distinctive contribution of PBL to differing achievement levels, changes in students' achievements at knowledge, comprehension and application levels were examined separately. Additionally, students were interviewed to get a better picture of those changes in both achievement and self-regulation and to learn more about what they think about the PBL application itself and the challenges experienced.

Results of statistical procedures revealed that both control and treatment groups were equal in their knowledge level achievements. However, significant differences ($p < .01$) were found in favor of the treatment group in relation to students' comprehension and application level achievements.

Considering the nature of PBL environments, where students participate in cooperative learning groups trying to find solutions to real-life problems, learning is more active than passive. Students have the chance to have access to and do research on more information and see the actual practical results of theoretical constructs, and eventually take the responsibility for their own learning. From this point of view, the results of this research could be considered predictable under such conditions. However, there are some mixed results in the literature. Some studies (Albanese & Mitchell, 1993; Colliver, 2000; Kalaian et al., 1999; Vernon & Blake, 1993) reveal lower outcomes on knowledge base in PBL settings, while others (Berkson, 1993; Dochy et al., 2003) conclude that students in PBL perform as well as students in conventional settings when their basic knowledge applications are examined. As also mentioned in some other studies (Barrows & Tamblyn, 1980; Savery & Duffy, 1995; Schmidt, Vermeulen, & Van Der Molen, 2006), the real power of PBL can be seen in activities based on application and in real-life problems encountered during occupational experiences. Revealing such findings, this particular study not only shows evidence of PBL's positive influence on students' attainments at knowledge level, but also its superiority on comprehension and application levels.

Considering all dimensions of the SSRL, there was no difference between the control and treatment groups. Although gains in the self-regulation levels of students in the treatment group were found to be higher than those of the students in the control group, the differences were not significant ($p > .05$). This result of no significant effect is also shared with many other reviews and studies (Berkson, 1993; Walker & Lofton, 2003), in contrast with others (Galand et al., 2005; Kivela & Kivela, 2005; Leary, 2012; Loyens et al., 2008; Sungur & Tekkaya, 2006) where evidence shows some significant effects on conative elements. There could be a number of reasons specific to the present study. First, the students in both groups attending the language teaching department of METU are among the top students in Turkey. Hence, it is believed that those students were already equipped with high self-regulatory skills. Second, the 15-week application could be insufficient to show real development in self-regulation. Just as they reported, Van den Hurk, Wolfhagen, Dolmans, and Van der Vleuten (1999) found that real development of self-regulation occurred only in the third and fourth grades. It is estimated that a better observation of self-regulatory skills development could be achieved through a study that would last three to four years.

The qualitative findings derived from the content analysis of student interviews seem to support the quantitative findings. The statements of students during interviews show some evidence of PBL's influence on all levels of achievements. Students claimed that they learned more during PBL application and they credited it to the hands-on activities in class, to the large number of various sources they referred to during their studies and to the opportunity of sharing the information among group members. When they shared responsibilities in group work, all students took active roles in their own learning. Besides, the high level of communication and interaction among group members helped creative and different ideas flourish, ensured every member took part in every piece of work of their group and established a fairly good level of peer support among group members. Students worked on real-life problems, focused on the process of their own learning and had the chance to be creative. When all these statements of students are reviewed, it is clear that their semester-end achievements are not coincidental but a product of a hard and continuous study which rested heavily on cooperation and facilitation. Obviously, the students in cooperative learning groups did more than a student in a traditional class would do.

Although their self-regulation levels are thought to have been high even at the beginning of the treatment, students showed some progress in a few aspects of their SRL skills. The students claimed that they had access to more sources in number and variety and that there was an increase in their self-confidence about testing and evaluation. Working on real-life problems helped students learn the value of the school subject, which may explain the increase in the task-value scores of students in the treatment group.

About PBL itself, the students had a few comments about its implementation. In the absence of tutorial rooms, the students had difficulty meeting outside classes; certainly the number of courses they had in their senior year left them not much time for their individual and group work. The teaching learning process in PBL is long, because individual and group activities in identifying problems, revealing and testing the hypotheses underlying the problem, sharing the information obtained and delivering the solutions to problems take substantial time. Students had some uncertainty about the PBL process at the beginning, but they learned their way around after some time. It is natural to have such challenges, because in a classroom setting where there is no right answer and the load is on students with enough guidance from a tutor or expert, the students will feel uncertain. Kivela and Kivela (2005) also suggest the same finding in their study and state that the uncertainty at the beginning of PBL tutorials vanishes as students become more experienced. The classes were usually noisy, a finding also noticed by Turan (2009) in her study. Although the groups in PBL tutorials are recommended to have seven to eight members (Barrows & Tamblyn, 1980), the students expressed their preferences of having groups of three to four students, especially for the ease of meetings outside classes. The students suggested the need for a group tutor that would lead them through all the PBL tutorials. Although the course instructor did a thorough job as a 'floating tutor,' the presence of separate tutors for all the groups would improve things further. The 'floating facilitator' model adopted in this version of PBL seems to be inadequate in satisfying students who had been taught passively in controlled and well-structured learning environments. The students' comments on working in groups, characteristics and responsibilities of a group leader and other group members suggest once again PBL's contribution to preparing students for their future work life, where they will have to work in

cooperation with their colleagues and/or lead study groups. During tutorials the students had the chance to share group responsibilities and they also saw that, for the success of group work, members should not only be responsible for their own learning, but also for the learning of other group members through interaction, appreciation of any related idea and peer facilitation. In addition to PBL's power in knowledge application (Barrows & Tamblyn, 1980), its contribution to social skills like group work, interaction, sharing responsibilities and leading a group is considered valuable. The students' comments on the testing and evaluation course provide some insight as well. PBL's focus on real-life problems and hands-on practice seemed to influence not only students' knowledge on testing, but also provided them with real experience of preparing and evaluating an exam, which in return increased their self-esteem. However, considering the heavy workload and scope of the course content, the students suggested a year-long course. Certainly the course should be restructured in order to cover the theories and applications related to language testing and evaluation and enough time should be spared for that purpose.

Finally, the PBL process with its focus on real-life ill-structured problems and use of cooperative learning groups shows promise for preparing prospective teachers for their future careers. As also stated by Murray-Harvey and Slee (2000), teacher education students will have to develop the lifelong learning skills of their students such as higher-order thinking and decision-making skills. They need to be prepared for that particular purpose. Experiencing PBL during teacher education years is believed to benefit teacher trainees in their future tasks as teachers to develop those thinking skills. The findings concerning PBL usage in medical education abound in literature (Barrows & Tamblyn, 1980; Savery & Duffy, 1995; Schmidt, 1983; Schmidt et al., 2006). Nevertheless, the findings of the present study have also demonstrated that PBL could equally be utilized successfully in the education of prospective teachers as it is used in the education of medical and engineering students. It is deemed important that for the successful application of methods like PBL, infrastructure needs should be met and necessary changes must be incorporated into the curriculum, especially to content and timing.

Conclusion

The present study examined the influence of PBL on achievements and self-regulatory skills of education students. However, the research has several limitations. First, the study was performed in a higher education institution with the participation of senior students taking the language testing and evaluation course, so care should be taken before findings are generalized to other settings and populations. Second, data were collected through achievement tests, a scale on self-regulation and students' interviews. Third, the implementation lasted 15 weeks (one semester). The replication of this research might reveal different results depending on student and course characteristics, length of study and data collection instruments developed and used.

In conclusion, PBL as an educational practice continues to have great impact at all levels of education and across different disciplines. While the results of studies examining the effects of PBL seem to be conclusive regarding students' problem-solving abilities, attitudes and predispositions toward learning, and clinical or occupational skills in application, much more needs to be known about PBL's influence on the

acquisition of basic knowledge and some conative elements such as self-direction/self-regulation.

Disclosure statement

No potential conflict of interest was reported by the authors.

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