Enhancing Pre-Service Elementary Teachers’ Self-Efficacy and Critical Thinking using Problem-Based Learning

by Anip Dwi Saputro

Research Article doi: 10.12973/eu-jer.9.2.765

European Journal of Educational Research

Volume 9, Issue 2, 765 - 773.

ISSN: 2165-8714
http://www.eu-jer.com/

Enhancing Pre-Service Elementary Teachers' Self-Efficacy and Critical Thinking using Problem-Based Learning

Anip Dwi Saputro*
Universitas Negeri Yogyakarta / Universitas Muhammadiyah Ponorogo, INDONESIA

Sri Atun
Universitas Negeri Yogyakarta, INDONESIA

Insih Wilujeng
Universitas Negeri Yogyakarta, INDONESIA

Ayok Ariyanto
Universitas Muhammadiyah Ponorogo, INDONESIA

Syamsul Arifin
Universitas Muhammadiyah Ponorogo, INDONESIA

Received: January 25, 2020 ▪ Revised: March 21, 2020 ▪ Accepted: April 4, 2020

Abstract: Self-efficacy and critical thinking represent two vital components for university graduates in the 21st century learning. However, several studies reported that these two important outcome predictors were unsatisfactory. This study aimed at investigating the effects of problem-based learning (PBL) on pre-service teachers' self-efficacy and critical thinking. A quasi-experimental nonequivalent pretest-posttest control group design was utilized. A total of 44 pre-service elementary school teachers (aged 19-22) at a private university in Indonesia were assigned as experimental (n = 22) and control (n = 22) groups. The experimental group learning received PBL, while the control group learning with traditional college instruction. The Self-Efficacy Scale (SES) and the Critical Thinking Questionnaire (CTQ) were administered before and after the intervention in both groups. Independent and paired samples t-tests were employed to analyze the pretests and posttests data. The results indicated that PBL was more effective in increasing self-efficacy and critical thinking of pre-service elementary teachers than traditional teaching. It is suggested that PBL should be used more frequently in science learning to further enhance students' self-efficacy and critical thinking skills in higher education.

Keywords: *Critical thinking, pre-service elementary teachers, problem-based learning, self-efficacy.*

To cite this article: Saputro, A. D., Atun, S., Wilujeng, I., Ariyanto, A., & Arifin, S. (2020). Enhancing pre-service elementary teachers' self-efficacy and critical thinking using problem-based learning. *European Journal of Educational Research, 9*(2), 765-773. https://doi.org/10.12973/eu-jer.9.2.765

Introduction

Nowadays, self-efficacy and critical thinking play an important role in supporting academic achievement in higher education and achieving success in the workplace. Bandura (1977, 1986) defined self-efficacy as one's belief in own ability to successfully carry out the desired action. In a similar manner, Lippke (2017) associated self-efficacy with one's purpose in setting goals; for instance, individuals with low self-efficacy tend to assume their efforts do not bring positive outcomes, whereas students having high self-efficacy are more likely to adopt a deep approach to their learning (Drysdale & McBeath, 2018). In fact, Schunk (1989) believed that students acting in ways that they believe to themselves (i.e., follow instructions, remember information, put out an effort to survive) will produce results that they value.

Previous studies reported that academic self-efficacy of students is in the average range (Chemers et al., 2001; Thompson & Verdino, 2018), thus it needs to be increased to a satisfactory level. In fact, self-efficacy is an essential psychological factor influencing achievement, academic motivation, persistence, learning success, and future career choice (Schunk, 1989; Thompson & Verdino, 2018; Webb-Williams, 2018). In another study, Alhadabi and Karpinski (2019) associated low self-efficacy with dishonest academic behavior. In short, this reflects that the experiences of pre-service teachers influence their self-efficacy beliefs, thus providing an active learning environment is considered an appropriate way to increase the self-efficacy of graduates (Sahin-Taskin, 2018). In other words, it is important for educators to promote students' self-efficacy (Wahyudiati et al., 2020) using effective teaching strategies.

* **Corresponding author:**
Anip Dwi Saputro, Graduate School of Yogyakarta State University, Yogyakarta 55281, Indonesia. ✉ anipdwisaputro@gmail.com

It should be noted that high self-efficacy does not produce good performance when the skills needed by students are lack (Schunk, 1995). One of the essential skills that need to be developed among pre-service teachers is critical thinking. Ennis (1985, 2011) defined critical thinking as "reasonable and reflective thinking focused on deciding what to believe or do". It means that critical thinking comes from everyday experience and then to various forms of inquiry, investigation, the examination of evidence, alternative exploration, argumentation, testing conclusions, re-thinking an assumption, and reflecting on the whole process (Spector, 2019). There is no clear consensus on the definition of critical thinking. However, critical thinkers are often regarded as reflective and independent thinkers, where they are required to have the ability to think clearly and rationally in solving problems (Higgins, 2014; Irwanto et al., 2018). In fact, Higgins believed that a good critical thinker means being proficient in classifying, inferring, analyzing, and evaluating information.

Basically, critical thinking (CT) is classified into two types, namely, skills and dispositions. Previous research claims that CT skills include a set of higher-order thinking skills such as evaluating, inferring and analyzing. In addition, CT dispositions include self-confidence, open-mindedness, and truth-seeking (Ennis, 1989; Facione, 2007). Although considered as a predictor of learning success, studies reported that students' critical thinking is at a low to medium level (e.g., Alper, 2010; Bakir, 2015; Irwanto et al., 2019). In fact, previous literature noted that CT influences academic achievement, reflective thinking, interpersonal skills, and problem-solving skills (Deal, 2004; Ghanizadeh, 2016; Kanbay & Okanli, 2017). Consequently, students who do not think critically will not be able to engage in effective decision making (Grussendorf & Rogol, 2018). Therefore, both critical thinking and self-efficacy should be developed among pre-service teachers using student-centered learning. Based on the literature on critical thinking (e.g., Gao et al., 2018; Kek & Huijser, 2011), student-centered learning environments such as PBL should be applied by educators to enhance the critical thinking skills of pre-service teachers. Therefore, in this study, we explore pre-service elementary school teachers' CT skills and their self-efficacy in higher education.

Previous studies revealed that problem-based learning (PBL) is a student-centered approach that effectively improves student learning. Savery (2006) specified PBL as an approach empowering students to integrate theory and practice, apply knowledge and skills, and develop appropriate solutions. PBL is rooted in constructivism providing opportunities for students to actively develop their own understanding of environmental issues and collaborate in producing solutions (Kuvac & Koc, 2018). In the PBL approach, problems are provided before relevant learning occurs (Smith, 2012). Because problems are important elements for learning, students are required to formulate an understanding of the problem and conduct investigations to generate a solution (Koray et al., 2008). It means that students are encouraged to comprehend situations that they have just encountered based on their prior knowledge (Temel, 2014), then linking real-world problems to classroom learning.

Various colleges and universities have implemented PBL to ensure students develop these transferable skills. In various empirical studies, PBL has a positive impact on student performance compared to traditional teaching. For instance, Smith (2012) reported that PBL developed skills of independent learning, teamwork, and communication. Gunter and Alpat (2017) found students in problem-based instruction had higher academic achievement compared to students in traditional teaching. In addition, Temel (2014) noted that PBL improved the problem-solving abilities of pre-service teachers rather than traditional teaching methods. Specifically, Tan (2004) also viewed PBL as an approach that encourages students to develop essential skills that they can use to overcome real-world problems. The results of previous studies revealed that the problem-based learning is more effective in promoting student performance than traditional methods. It indicates that PBL can be used as an effective tool in teaching science in the 21st century.

The importance of PBL was expressed by Overton and Randles (2015) by stating that students can think critically and be able to solve unstructured real-world problems. Significantly, previous empirical evidence has revealed the effectiveness of PBL in various fields. For example, the effect of PBL on pre-schoolers' scientific creativity (Siew et al., 2017), seventh-grade students' attitudes towards science (Akınoğlu & Tandoğan, 2007), eighth-grade students' biology academic achievement (Araz & Sungur, 2007), college students' motivation to learn physics (Shishig et al., 2017), and university students' chemistry conceptual problems (Bilgin et al., 2009) has been investigated. However, limited studies report the impact of PBL on self-efficacy and critical thinking (e.g. Temel, 2014). Whereas pre-service teachers need to be actively involved in problem-based learning activities that can improve their affective and cognitive domains. As a result, in this study, the effect of PBL on pre-service teachers' self-efficacy and their critical thinking skills was explored.

Research Objective

This study aims at investigating the effects of PBL on self-efficacy and critical thinking skills of pre-service elementary school teachers. Research questions are:

1. Are there significant differences in pretest and posttest scores between the experimental and control groups in terms of self-efficacy and critical thinking?
2. Are there significant differences in pretest and posttest scores among the experimental groups in terms of self-efficacy and critical thinking?

3. Are there significant differences in pretest and posttest scores among the control groups in terms of self-efficacy and critical thinking?

Methodology

Research Design

This study used a quasi-experimental nonequivalent pretest-posttest control group design (Campbell & Stanley, 1963) to compare the effects between PBL and traditional instruction in improving students' self-efficacy and critical thinking skills (see Table 1). We assigned two classes as randomly experimental and control groups. In educational research, random assignment aims at controlling the threat of subject characteristics to internal validity (Fraenkel & Wallen, 2006). The independent variables are teaching methods (i.e., PBL and traditional college instruction), and the dependent variable is self-efficacy and critical thinking of pre-service elementary teachers.

Table 1. Nonequivalent pretest-posttest control group design

Groups	Pretests	Processes	Posttests
Experimental	Self-Efficacy Scale (SES) Critical Thinking Questionnaire (CTQ)	Problem-Based Learning (PBL)	Self-Efficacy Scale (SES) Critical Thinking Questionnaire (CTQ)
Control	Self-Efficacy Scale (SES) Critical Thinking Questionnaire (CTQ)	Traditional College Instruction (TCI)	Self-Efficacy Scale (SES) Critical Thinking Questionnaire (CTQ)

Setting and Participants

Participants were 44 college students undergoing pre-service elementary school teachers aged 19-22 years who were enrolled in the Elementary Science II course, a compulsory program for one semester. The study was conducted at the Department of Elementary School Teacher Education of a medium-sized private university in Ponorogo Regency, Indonesia. The experimental group consisted of 22 students (15 females, 7 males). The control group consisted of 22 students (12 females, 10 males). All students in the experimental and control groups were taught by a male instructor with 6 years of teaching experience (33 years old). This course is instructed in three class hours (i.e. 3 × 45 min) per week for six weeks (6 × 3 × 45 min = 810 min in total) in the first semester of the academic year 2019/2020. The instructor is a volunteer and has received training in subject matter and pedagogy before treatment.

Treatments

After obtaining permission to conduct a study from the Department of Elementary School Teacher Education, students signed the consent forms and returned them to the researchers. For the record, all students participated voluntarily in this study. They completed pre- and posttests. There were no students who withdrew from this study. During treatment, students in the experimental group were instructed by PBL, while the control group was taught using traditional college instruction. Both groups learn the same topic: living things, living organisms and their environment, and health and disease. For the experimental group, the researchers developed three problem scenarios related to students' real-life situations. All problem scenarios were validated by two experts, and then revised based on their feedback. The problem scenarios were designed to develop students' ability to solve problems in their daily-life contexts.

Treatment in Experimental Group

The researchers used seven steps in PBL proposed by Schmidt (1983). In this student-centered learning, students work in small groups (4-5 students), and the instructor acts as a facilitator. Before the application, students in the experimental group were given information about problem-based learning. PBL was implemented for 18 class hours in a six-week period. First, students read a problem scenario carefully, marked and explained unknown concepts within the group. Second, they produced a problem definition. Third, students analyzed the problem and made a logical explanation using their prior knowledge. Next, students discussed to solve problems. Fifth, each group member formulated and clarified the problem. Sixth, students investigated an issue according to a work plan. Finally, all group members synthesized the knowledge they obtained, made an explanation of the phenomenon, and provided solutions based on the discussion.

Treatment in Control Group

In the control group, students tended to listen to lectures, and instructor dominated the transfer of knowledge in the classroom using PowerPoint slides. In this context, the intervention was based on textbooks provided by the university. The instructor gave lectures and asked students to read and record textbooks. After that, the instructor asked students to answer the questions listed in the textbook in groups (4-5 students). In the end, students asked questions when they experienced difficulties.

Data Collection

In order to evaluate students' self-efficacy and critical thinking, two instruments were used as pretests and posttests. They are the Self-Efficacy Scale (SES) and the Critical Thinking Questionnaire (CTQ). The SES and CTQ were composed by researchers and have been face-validated by three experts in science education.

Self-Efficacy Scale (SES)

The authors developed SES to assess students' self-efficacy in elementary science courses. The SES consists of 3 dimensions (i.e., magnitude, generality, and strength) adapted from Bandura (1977), Pajares (1996), and Zimmerman (2000). These three dimensions have a total of 7 items with a 5-point Likert-type scale from strongly disagree (1) to strongly agree (5). For example, the five items in SES are: "*I can confidently complete a difficult task on time*", "*When my grades are not satisfying, I will try to study harder*", "*I can always solve the problems I face calmly*", "*I usually try to complete the task well using various efforts*", and "*I can think clearly even under pressure to achieve my goals*". The highest score is 35 (i.e., 5 points × 7 items = 35 points). SES has been validated by experts. The coefficient of Cronbach's alpha reliability was 0.81, which indicates high reliability (Pallant, 2011).

Critical Thinking Questionnaire (CTQ)

In order to measure students' critical thinking, the authors designed CTQ. The CTQ includes six subscales, which are problem-solving, the ability to ask questions, make conclusions, analyze the arguments, answer questions, and collaborative abilities, in which they were adapted from Ennis (1996, 2011). It consists of 13 items measured on a 5-point Likert scale ranging from Strongly Agree (5) to Strongly Disagree (1). Five examples of statements in CTQ are: "*I communicate with others effectively to solve complex problems*", "*I look for alternative possibilities when drawing a conclusion*", "*I try to develop my own ideas*", "*I often collect and review relevant information as supporting evidence*", and "*I accept the thought of peers to find a logical solution*". In this study, 65 (i.e., 5 points × 15 items = 65 points) is the highest score, and 13 is the lowest score. After being validated and tested on a pilot study, the coefficient of Cronbach's alpha reliability was found at 0.76.

Data Analysis

In this study, we utilized descriptive statistics to present the mean scores and standard deviation. The Kolmogorov–Smirnov test was chosen to test the normal distribution hypothesis. Levene's test was used to test the variance homogeneity hypothesis. After fulfilling the assumption test ($p > 0.05$), an independent samples *t*-test was performed to compare pretest and posttest scores between the experimental and control groups. Paired samples *t*-tests were then employed to confirm whether there were changes in pretest and posttest scores in groups. In addition, the effect size (*d*) was calculated to understand the strength of the difference between self-efficacy and critical thinking of students before and after treatment (Cohen, 1988); value of 0.20 to 0.30 was classified as small effects; 0.40 to 0.70 was classified as medium effects; more than 0.80 was classified as large effects (Cohen, 1988). Data were analyzed using SPSS 17.0 at a significance level of 0.05.

Findings

Effect on Pre-service Teachers' Self-Efficacy

Descriptive statistics related to the mean scores of pretest and posttest for self-efficacy are presented in Tables 2 and 3. The mean scores of pretest from the experimental group ($M = 20.45$; $SD = 1.405$) was slightly lower than the control group ($M = 20.95$; $SD = 1.963$).

Table 2. Independent samples t-test results on pretest scores between the two groups

Groups	N	M	SD	*t*	*df*	*p*
Experimental	22	20.45	1.405	-0.971	42	0.337
Control	22	20.95	1.963			

The mean scores of self-efficacy for pre-treatment was $M = 20.45$ and $M = 20.95$ for the experimental and control groups, respectively. Independent samples *t*-test showed that there were no statistical differences between students' critical thinking before instruction [$t(42) = -0.971$; $p > 0.05$].

Table 3. Independent samples t-test results on posttest scores between the two groups

Groups	N	M	SD	*t*	*df*	*p*
Experimental	22	31.50	1.711	7.222	42	0.000
Control	22	27.45	1.993			

Table 3 shows that the mean scores of posttest from the experimental group (M = 31.50; SD = 1.711) was higher than the control group (M = 27.45; SD = 1.993). After the intervention, there was a statistical difference between students' critical thinking after the intervention [$t(42) = 7.222$; $p > 0.05$].

In order to test the increase in students' self-efficacy from the experimental group, paired samples *t*-test was conducted, and the data is presented in Table 4.

Table 4. Paired samples t-test results for experimental group students' self-efficacy

Pretest		Posttest		Paired Differences		*t*	*df*	*p*	Cohen's *d*
M	SD	M	SD	M	SD				
20.45	1.405	31.50	1.711	-11.045	2.340	-22.143	21	0.000	5.34

As shown in Table 4, there were statistically significant differences in students' self-efficacy scores before and after PBL intervention [t (21) = -22.143; $p < 0.05$]. After calculating the effect size, the increase in the mean score of self-efficacy is high (d = 5.34). It can be said that the teaching method in the experimental group has a positive effect on students' self-efficacy.

Effect on Pre-service Teachers' Critical Thinking Skills

Descriptive statistics related to the mean scores of pretest and posttest for critical thinking are presented in Tables 5 and 6.

Table 5. Independent samples t-test results on pretest scores between the two groups

Groups	N	M	SD	*t*	*df*	*p*
Experimental	22	37.64	3.659	-.117	42	0.907
Control	22	37.77	4.047			

The experimental group (M = 37.64; SD = 3.659) had an mean score of pretest from was slightly lower than the control group (M = 37.77; SD = 4.047). However, the results of the independent samples *t*-test confirmed that there were no statistically significant differences in the mean score of the pretest between the experimental and control groups [$t(42) = -0.117$; $p > 0.05$] before treatment.

Table 6. Independent samples t-test results on pretest scores between the two groups

Groups	N	M	SD	*t*	*df*	*p*
Experimental	22	57.77	2.810	11.237	42	0.000
Control	22	48.27	2.798			

Based on Table 6, it seems that the experimental group (M = 57.77; SD = 2.810) performed better than the control group (M = 48.27; SD = 2.798) on the posttest. After the intervention, there was a statistically significant difference between students' mean scores in the posttest [t (42) = 11.237; $p < 0.05$].

In addition, paired samples *t*-test was also carried out to explore whether there were significant differences between the mean score of the pretest and posttest from the experimental group students. The statistical values are summarized in Table 7.

Table 7. Paired samples t-test results for experimental group students' critical thinking skills

Pretest		Posttest		Paired Differences		*t*	*df*	*p*	Cohen's *d*
M	*SD*	*M*	*SD*	*M*	*SD*				
37.64	3.659	57.77	2.810	-20.136	4.324	-21.844	21	0.000	6.69

According to Table 7, students' critical thinking had increased during treatment, and the results of paired samples *t*-test [t (21) = -21.844] between pretest and posttest scores were statistically significant at $p < 0.05$. The effect size was found to be very high (d = 6.69) in students' critical thinking skills. From the results, it can be understood that PBL is more effective in increasing the critical thinking skills of experimental group students than traditional college instruction.

Discussion

This study had investigated the efficacy of PBL in improving the self-efficacy and critical thinking skills of pre-service elementary school teachers in science. Regarding the pretest results, there were no statistically significant differences between the experimental and control groups in terms of self-efficacy and critical thinking skills. This finding indicated that the mean scores of pre-service teachers in the experimental and control groups were generally similar before treatment. However, at the end of the instruction, students in the experimental group showed higher performance than those who are in the control group. On the other hand, in this study, a decrease was observed in the mean score of the control group students in terms of self-efficacy, after treatment. It can be claimed that the elementary school science course with a traditional college instruction was insufficient in increasing students' self-efficacy in the learning process. Accordingly, the PBL environment was believed to contribute significantly to increasing students' self-efficacy. This situation happened maybe because the current learning settings set students being asked to solve real-world problems that are unstructured in groups (Hmelo-Silver, 2004). When students analyze daily life problems, they believe that science courses become more interesting and enjoyable. As a result, pleasant learning influences students' self-efficacy, academic achievement, and their learning success (Saputro et al., 2019; van Rooij et al., 2017).

Another reason is that the instructor acts as a facilitator in PBL settings. Under the guidance of the instructor, students are encouraged to develop arguments, ask questions, and solve the problem in groups. Finally, Kristiansen et al. (2019) reported that working in cooperative groups increased students' problem-solving skills, collaborative work, and self-confidence. The increase of students' self-efficacy in the current study is evidenced by the statistically significant posttest scores supporting the findings of Cerezo (2004) and Dunlap (2005), in which active involvement of students in small group discussions successfully promotes students' efficacy. Mataka and Kowalske (2015) agreed that a learning environment providing students with authentic experiences and providing more responsibility for their learning was considered to improve self-efficacy. Similar positive results were also reported by Papinczak et al. (2007).

Changes in students' critical thinking scores were evident from the results of the statistically significant paired samples *t*-test. The students in the experimental group got better mean scores of the posttest than their counterparts (those in the control group). On the other hand, an increase was not found significant in the mean score of the control group students in terms of critical thinking skills. It indicates PBL is an effective tool to promote students' critical thinking. Thus, these findings reveal that the elementary science course conducted using the PBL method has a positive and significant effect on critical thinking of pre-service teachers. The situation happened maybe because it is inseparable from the role of instructors ensuring students maintain their focus and stimulate learning using high-level contextual questions during the intervention (Haruehansawasin & Kiattikomol, 2017). This is due to the effective environment supporting the learning process being able to facilitate the development of students' critical thinking and problem-solving skills (Gregory & Lodge, 2015; Irwanto et al., 2019).

We predict that students who are actively involved in the PBL environment are able to solve problems and apply their learning experiences to real-world situations (Beringer, 2007; Engel, 1991). It is due to problems related to everyday situations helping every knowledge acquired by students become permanent (Gunter & Alpat, 2017), and it improves their critical reasoning at the same time. This is in line with the opinion of Das et al. (2002), stating that educators in PBL play a role in fostering critical thinking. In light of these findings, Barnett and Francis (2012) suggested that students' critical thinking can be grown using higher-order thinking questions. These results are consistent with findings in the literature reporting the positive effects of PBL on students' critical thinking (e.g., Kek & Huijser, 2011; Wilder, 2014).

Conclusions and Limitations

In conclusion, the results obtained from this study indicate that problem-based learning is more effective in increasing the self-efficacy and critical thinking skills of pre-service elementary teachers. Students in the PBL environment performed better than the expository teaching approach. The high exposure to a student-centered approach might be the reason for the statistically significant increase in the mean scores on both dependent variables. Based on the findings, it is suggested that PBL should be used more frequently in science learning in higher education to further enhance self-efficacy and critical thinking of pre-service teachers. In the Indonesian context, Rusmansyah et al. (2019) also suggested that PBL effectively promoted students' critical thinking skills and self-efficacy in higher education. Therefore, we believe our work contributes to preparing students as a science teacher at the primary level in the near future.

As a limitation, the current study did not consider factors of age, gender, and prior learning experiences that might affect student skills. It is recommended to investigate the effect of PBL on student performance based on age, gender, and prior learning experience to obtain comprehensive findings. In addition, the current study is limited to 44 students at an Indonesian private university, thus it will be useful to conduct further research with a larger sample. Interestingly, during the intervention, the researchers observed an increase in self-efficacy over several weeks, and we predict that if the intervention period is longer, the more the increase of students' self-efficacy and critical thinking will develop. Then, the current study is quantitative research. Using interviews for future studies will strengthen quantitative findings. Finally, further work can also investigate the effect of PBL on self-efficacy and critical thinking about science concepts at other elementary levels.

References

Akinoglu, O., & Tandogan, R. O. (2007). The effects of problem-based active learning in science education on students' academic achievement, attitude and concept learning. *Eurasia Journal of Mathematics, Science and Technology Education, 3*(1), 71–81.

Alhadabi, A., & Karpinski, A. C. (2019). Grit, self-efficacy, achievement orientation goals, and academic performance in university students. *International Journal of Adolescence and Youth, 25*(1), 519-535.

Alper, A. (2010). Critical thinking disposition of preservice teachers. *Education and Science, 35*(158), 14–27.

Araz, G., & Sungur, S. (2007). Effectiveness of problem-based learning on academic performance in genetics. *Biochemistry and Molecular Biology Education, 35*(6), 448–451.

Bakir, S. (2015). Critical thinking dispososition of preservice teachers. *Educational Research and Review, 10*(2), 225–233.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall.

Barnett, J. E., & Francis, A. L. (2012). Using higher order thinking questions to foster critical thinking: A classroom study. *Educational Psychology, 32*(2), 201–211.

Beringer, J. (2007). Application of problem based learning through research investigation. *Journal of Geography in Higher Education, 31*(3), 445–457.

Bilgin, I., Senocak, E., & Sozbilir, M. (2009). The effects of problem-based learning instruction on university students' performance of conceptual and quantitative problems in gas concepts. *Eurasia Journal of Mathematics, Science and Technology Education, 5*(2), 153–164.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experiment designs for research.* Houghton Mifflin Company.

Cerezo, N. (2004). Problem-based learning in the middle school: A research case study of the perceptions of at-risk females. *RMLE Online, 27*(1), 1–13.

Chemers, M. M., Hu, L., & Garcia, B. F. (2001). Academic self-efficacy and first-year college student performance and adjustment. *Journal of Educational Psychology, 93*(1), 55–64.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences*. Erlbaum.

Das, M., Mpofu, D. J. S., Hasan, M. Y., & Stewart, T. S. (2002). Student perceptions of tutor skills in problem-based learning tutorials. *Medical Education, 36*(3), 272–278.

Deal, K. H. (2004). The relationship between critical thinking and interpersonal skills. *The Clinical Supervisor, 22*(2), 3–19.

Drysdale, M. T. B., & McBeath, M. (2018). Motivation, self-efficacy and learning strategies of university students participating in work-integrated learning. *Journal of Education and Work*, *31*(5-6), 478–488.

Dunlap, J. C. (2005). Problem-based learning and self-efficacy: How a capstone course prepares students for a profession. *Educational Technology Research and Development, 53*(1), 65–83.

Engel, C. E. (1991). Not just a method but a way of learning. In D. Boud & G. Feletti (Eds.), *The challenge of problem-based learning* (pp. 22–33). Kogan.

Ennis, R. H. (1985). The logical basis for measuring critical thinking skills. *Educational Leadership, 43*(2), 44-48.

Ennis, R. H. (1996). *Critical thinking.* Prentice Hall.

Ennis, R. H. (2011). *The nature of critical thinking: An outline of critical thinking dispositions and abilities.* Illinois College of Education. https://education.illinois.edu/docs/default-source/faculty-documents/robert-ennis/thenatureofcriticalthinking_51711_000.pdf

Fraenkel, J. R., & Wallen, N. E. (2006). *How to design and evaluate research in education* (6th ed). McGraw-Hill.

Gao, S., Wang, Y., Jiang, B., & Fu, Y. (2018). Application of problem-based learning in instrumental analysis teaching at Northeast Agricultural University. *Analytical and Bioanalytical Chemistry, 410*(16), 3621–3627.

Ghanizadeh, A. (2016). The interplay between reflective thinking, critical thinking, self-monitoring, and academic achievement in higher education. *Higher Education, 74*(1), 101–114.

Gregory, M. S.-J., & Lodge, J. M. (2015). Academic workload: The silent barrier to the implementation of technology-enhanced learning strategies in higher education. *Distance Education, 36*(2), 1–21.

Grussendorf, J., & Rogol, N. C. (2018). Reflections on critical thinking: Lessons from a quasi-experimental study. *Journal of Political Science Education, 14*(2), 151–166.

Gunter, T., & Alpat, S. K. (2017). The effects of problem-based learning (PBL) on the academic achievement of students studying "electrochemistry." *Chemistry Education Research and Practice, 18*(1), 78–98.

Haruehansawasin, S., & Kiattikomol, P. (2017). Scaffolding in problem-based learning for low-achieving learners. *The Journal of Educational Research, 111*(3), 363–370.

Higgins, S. (2014). Critical thinking for 21st-century education: A cyber-tooth curriculum? *Prospects, 44*(4), 559–574.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235–266.

Irwanto, Rohaeti, E., & Prodjosantoso, A. K. (2019). Analyzing the relationship between science process skills and critical thinking skills of pre-service chemistry teachers. *Journal of Turkish Science Education, 16*(3), 299-313.

Irwanto, Saputro, A. D., Rohaeti, E., & Prodjosantoso, A. K. (2018). Promoting critical thinking and problem solving skills of preservice elementary teachers through process-oriented guided-inquiry learning (POGIL). *International Journal of Instruction, 11*(4), 777-794.

Irwanto, Saputro, A. D., Rohaeti, E., & Prodjosantoso, A. K. (2019). Using inquiry-based laboratory instruction to foster critical thinking and science process skills among preservice elementary teachers. *Eurasian Journal of Educational Research, 80*, 151-170.

Kanbay, Y., & Okanli, A. (2017). The effect of critical thinking education on nursing students' problem-solving skills. *Contemporary Nurse, 53*(3), 313–321.

Kek, M. Y. C. A., & Huijser, H. (2011). The power of problem-based learning in developing critical thinking skills: preparing students for tomorrow's digital futures in today's classrooms. *Higher Education Research & Development, 30*(3), 329–341.

Koray, O., Presley, A., Koksal, M. S., & Ozdemir, M. (2008). Enhancing problem-solving skills of pre-service elementary school teachers through problem-based learning. *Asia-Pacific Forum on Science Learning and Teaching, 9*(2), 1-18.

Kristiansen, S. D., Burner, T., Johnsen, B. H., & Yates, G. (2019). Face-to-face promotive interaction leading to successful cooperative learning: A review study. *Cogent Education, 6*(1), 1674067. https://doi.org/10.1080/2331186X.2019.1674067

Kuvac, M., & Koc, I. (2018). The effect of problem-based learning on the environmental attitudes of preservice science teachers. *Educational Studies, 45*(1), 72–94.

Lippke, S. (2017). Self-efficacy theory. In V. Zeigler-Hill & T. K. Shackelford (Eds.), *Encyclopedia of personality and individual differences* (pp.1-6). https://doi.org/10.1007/978-3-319-28099-8_1167-1

Mataka, L. M., & Kowalske, M. G. (2015). The influence of PBL on students' self-efficacy beliefs in chemistry. *Chemistry Education Research and Practice, 16*(4), 929–938.

Overton, T. L., & Randles, C. A. (2015). Beyond problem-based learning: using dynamic PBL in chemistry. *Chemistry Education Research and Practice, 16*(2), 251–259.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66*(4), 543–578.

Pallant, J. (2011). *SPSS survival manual: A step by step guide to data analysis using SPSS*. Allen & Unwin.

Papinczak, T., Young, L., Groves, M., & Haynes, M. (2007). An analysis of peer, self, and tutor assessment in problem-based learning tutorials. *Medical Teacher, 29*(5), e122–e132.

Rusmansyah, Yuanita, L., Ibrahim, M., Isnawati, Prahani, B.K. (2019). Innovative chemistry learning model: Improving the critical thinking skill and self-efficacy of pre-service chemistry teachers. *Journal of Technology and Science Education, 9*(1), 59-76.

Sahin-Taskin, C. (2018). Effects of active learning environments supported with self- and peer assessment on pre-service teachers' pedagogical and self-efficacy beliefs. *Asia-Pacific Journal of Teacher Education*, *46*(5), 421–440.

Saputro, A. D., Irwanto, Atun, S., & Wilujeng, I. (2019). The impact of problem solving instruction on academic achievement and science process skills among prospective elementary teachers. *Elementary Education Online, 18*(2), 496-507.

Schmidt, H. G. (1983). Problem-based learning: Rationale and description. *Medical Education, 17*(1), 11–16.

Schunk, D. H. (1989). Self-efficacy and achievement behaviors. *Educational Psychology Review, 1*(3), 173-208.

Schunk, D. H. (1995). Self-efficacy and education and instruction. In J. E. Maddux (Ed.), *Self-efficacy, adaptation, and adjustment* (pp. 281–303). Springer.

Shishigu, A., Hailu, A., & Anibo, Z. (2017). Problem-based learning and conceptual understanding of college female students in physics. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(1), 145–154.

Siew, N. M., Chin, M. K., & Sombuling, A. (2017). The effects of problem based learning with cooperative learning on preschoolers' scientific creativity. *Journal of Baltic Science Education, 16*(1), 100-112.

Smith, C. J. (2012). Improving the school-to-university transition: Using a problem-based approach to teach practical skills whilst simultaneously developing students' independent study skills. *Chemistry Education Research and Practice, 13*(4), 490–499.

Spector, J. M. (2019). Complexity, inquiry critical thinking, and technology: a holistic and developmental approach. In Parsons T., Lin L., Cockerham D. (Eds), *Mind, brain and technology. Educational communications and technology: Issues and innovations*. Springer, Cham.

Tan, O. S. (2004). Cognition, metacognition, and problem-based learning. In O. S. Tan (Ed.), *Enhancing thinking through problem-based learning approaches: International perspectives* (pp.1–16). Thomson Learning.

Temel, S. (2014). The effects of problem-based learning on pre-service teachers' critical thinking dispositions and perceptions of problem-solving ability. *South African Journal of Education, 34*(1), 1-20.

Thompson, K. V., & Verdino, J. (2018). An exploratory study of self-efficacy in community college students. *Community College Journal of Research and Practice, 43*(6), 476–479.

van Rooij, E. C. M., Jansen, E. P. W. A., & van de Grift, W. J. C. M. (2017). Factors that contribute to secondary school students' self-efficacy in being a successful university student. *Research in Post-Compulsory Education, 22*(4), 535–555.

Wahyudiati, D., Rohaeti, E., Irwanto, Wiyarsi, A., & Sumardi, L. (2020). Attitudes toward chemistry, self-efficacy, and learning experiences of pre-service chemistry teachers: Grade level and gender differences. *International Journal of Instruction, 13*(1), 235-254.

Webb-Williams, J. (2018). Science self-efficacy in the primary classroom: Using mixed methods to investigate sources of self-efficacy. *Research in Science Education, 48*(5), 939–961.

Wilder, S. (2014). Impact of problem-based learning on academic achievement in high school: A systematic review. *Educational Review, 67*(4), 414–435.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology, 25*(1), 82–91.

Enhancing Pre-Service Elementary Teachers' Self-Efficacy and Critical Thinking using Problem-Based Learning

ORIGINALITY REPORT

19%	15%	17%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	doaj.org Internet Source	8%
2	Meltem Kuvac, Isil Koc. "The effect of problem-based learning on the metacognitive awareness of pre-service science teachers", Educational Studies, 2018 Publication	3%
3	Submitted to University of Edinburgh Student Paper	2%
4	repositorio.uam.es Internet Source	1%
5	un-pub.eu Internet Source	1%
6	ilkogretim-online.org.tr Internet Source	1%
7	academicjournals.org Internet Source	1%
8	archive.org Internet Source	

1 %

9	Erdal Senocak, Yavuz Taskesenligil, Mustafa Sozbilir. "A Study on Teaching Gases to Prospective Primary Science Teachers Through Problem-Based Learning", Research in Science Education, 2006 Publication	1 %

Exclude quotes	On	Exclude matches	< 40 words
Exclude bibliography	On		