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Research Article

Blended-Problem-Based Learning: How its impact on students' critical thinking skills?

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ABSTRACT

Critical thinking skills are one of the four main competencies that must be empowered in the 21st-Century Learning. This study aimed to describe students' critical thinking skills through the application of blended-problem-based learning (PBL) in the Cell Biology course. The data sources of this research were 28 students who were taking Cell Biology Course in Department of Biology Education, Universitas PGRI Madiun. The research instruments used were 1) observation sheet, 2) interview guidelines, and 3) critical thinking skills test. The study was designed by applying blended-PBL on 12 topics. The data analysis was performed in descriptive qualitative. The results showed that the application of blended-PBL was able to train students to improve their critical thinking skills in term of how to answer the test given. However, further studies need to be done with a wider number of samples and material scope to get more comprehensive information.

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INTRODUCTION

The 21st-Century Learning emphasizes the various skills students must possess, such as a variety of thinking (Dwyer, Hogan, & Stewart, 2014; Greiff, Niepel, & Wüstenberg, 2015) and communication skills (Siddiq, Scherer, & Tondeur, 2016). Among the various thinking skills, critical thinking skills (CTS) and problem-solving are considered as the main essential skills that must be possessed by every student (Dwyer et al., 2014; Schmaltz, Jansen, & Wenckowski, 2017). CTS included the higher-order thinking skills (HOTS) that is suitable for someone to face the development of the world today (Crowley, 2015). Critical thinkers will have the ability to think scientifically, reflectively and focus on deciding something about what to believe and do (Ennis,

2011). Furthermore, practicing CTS is an important component that must be considered in higher education institution and needs to be developed especially for undergraduate students (Kumar & James, 2015).

Stimulating students to think critically is needed in learning and one of the learning models that can sharpen student CTS is Problem-Based Learning (PBL) (Masek & Yamin, 2011; Temel, 2014). This learning model can train CTS because it actively involves students to solve problems through the stages of the scientific method (Isabekov & Sadyrova, 2018). PBL meets the characteristics of Student-Centered Learning (Lopes et al., 2020), so that it can encourage students to learn and work cooperatively to practice analytical critical thinking in finding solutions. The advantage of PBL is to familiarize students with overcoming problems through case study simulations in class based on problems of daily life so as to foster social solidarity in discussions (Batdi, 2014). In addition, PBL is able to train students in using various concepts, principles and skills that they have learned to solve the problems encountered (Yew & Goh, 2016). Based on some of the results of these studies, the implementation of PBL needs to be conducted for various subjects in Higher Education, one of which is the Cell Biology course.

Cell Biology is a compulsory subject in the Biology education study program with abstract concepts which makes it difficult for students to study it (Lukitasari & Susilo, 2014). The statement was also supported by a report that identified Cell Biology, including courses that were considered difficult by some students majoring in biology (Fauzi & Fariantika, 2018). Students tend to memorize results rather than study and discover the processes of chemical reactions that occur in cells. Based on the characteristics of the Cell Biology course, students must have the ability to reason logically, think analytically and have a strong imagination. Therefore, the application of PBL is expected could to improve the competence of students in Cell Biology course.

However, despite having many advantages, PBL was identified as having weaknesses caused by various reasons (Ates & Eryilmaz, 2011). One of the challenges that sometimes becomes the main obstacle in implementing PBL is time. Earlier reports inform that from the teacher's perspective, PBL activities require a lot of time allocation (Blackwell & Roseth, 2018). These findings are in line with statements in other references which state that PBL requires more time allocation than traditional learning (Marta, 2011). In addition, the activity of delivering knowledge cannot be done by the teacher so that it becomes a problem for the teacher (Pagander & Read, 2014). Furthermore, evaluation activities are still difficult for teachers to implement when they implement PBL (Ates & Eryilmaz, 2011; Pagander & Read, 2014).

To minimize PBL weaknesses and optimize their effectiveness, various studies have also examined the effect of blended learning during PBL implementation. Combining face to face with online learning have reported could to improve students' HOTS (Lukitasari, Handhika, & Murtafiah, 2018; Lukitasari, Handhika, & Murtafiah, 2016). Furthermore, one study reported that by integrating PBL with online learning, motivation and scientific communication of students could increase (Suwono & Dewi, 2019). The implementation of PBL is more efficient when the combination is carried out (Ammann, Vignoli, & Kaap-Fröhlich, 2019). The results of the meta-analysis also inform that blended-PBL is more effective than traditional PBL (Car et al., 2019). Blended-PBL was also reported to be more effective in creating active learning in Asian students (Shimizu, Nakazawa, Sato, Wolfhagen, & Könings, 2019).

Several studies on blended-PBL have been carried out by other researchers. However, this research is still limited to a variety of specific research subjects. In the Biology Education field, research subjects in previous reports also often use high school students (Suwono & Dewi, 2019). Whereas various studies in higher education examining blended-PBL implementation often involve medical students (Car et al., 2019) or health (Ammann et al., 2019; de Jong, Krumeich, & Verstegen, 2017). In addition to the limitations of the research subject, the competencies analyzed in the various studies are also limited to students' scientific motivation and communication (Suwono & Dewi, 2019) and the mastery of knowledge (Car et al., 2019; Shimizu et al., 2019). Therefore, the purpose of this study was to examine the impact of Blended-PBL on students' CTS.

METHOD

The research was carried out in the Biology Education study program, the Teaching and Education Faculty of the Universitas PGRI Madiun in the Cell Biology course. The study was conducted from April to June 2019. The source of the research data was the second semester students of Biology Education Study Program as many as 28 students. The study was conducted by means of observation during learning activities by using blended-PBL for 12 subjects in the Cell Biology course. Google Classroom (GC) was a Learning Management System (LMS) chosen to accommodate online learning.

The research instruments used were: 1) questionnaire, to find out the implementation of blended learning in terms of (a) attention, (b) relevance, (c) self-confident, (d) information Literacy, (e) student attitudes toward Blended-PBL, and (f) student evaluation about Blended-PBL. The questionnaire contained 20 statements and

had a range of scores from 1-5 which was then converted into the following percentage form (0-20% = Very Bad, 21-40% = Poor, 41-60% = Enough, 61-80% = Good, and 81-100% = Very Good). Questionnaire was given to students with high and low academic ability. This step was conducted to find a comprehensive picture of how students respond to the implementation of blended learning for all academic levels; 2) interview guidelines, to confirm the results of working on a critical thinking test; 3) documentation, results of working on students' critical thinking skills; and 4) CTS test, to measure students' critical thinking skills in the form of 10 multiple choice questions and essays for 3 questions and is applied to pretest and posttest.

The test was arranged based on 5 aspects of CTS according to Ennis (2011) which were elaborated into 12 indicators. Pretest results are classified into high and low categories based on the scoring rubric of critical thinking skills developed by Zubaidah, Corebima, and Mistianah (2015), and then compared with the posttest results. Aspects and indicators of CTS test and the implementation of blended-PBL as shown in Table 1. Next, the data analysis was done descriptively to describe the condition of students' critical thinking skills after applying blended-PBL lectures in the Cell Biology course.

Table 1. CTS aspects and indicators as well as blended learning activity in this study

No.	CTS aspects	CTS indicators	Topics	Learning form
1.	Provide a simple explanation	Focus the question	Cell membrane	face to face
		Ask and answer questions that require challenges	Endomembrane System and Structure	Online
			Mitochondrial Function	face to face
		Analyze arguments	Cytoskeleton	Online
2.	Develop basic skills	Observation and consider the results of the observation report	Cell Cycle	
3.	Drawing conclusions	Make decisions and consider the results	Cell Membrane	Online
			Protein Synthesis	face to face
		Compile and consider induction	Cell interactions and communication	face to face
			Cell Cycle	Online
4.	Provide further explanation	Identifying assumptions	Genetic Material	Online
		Identify terms and consider definitions	Endomembrane System	face to face
5.	Set strategy and tactics	Determine the action	Genetic Material	Online

RESULTS AND DISCUSSION

PBL is innovative learning that has the potential to create effective learning. Combining PBL with online learning is indicated could to increase the effectiveness of the learning. Changes in student responses before and after the blended-PBL implementation implemented in this study are presented in Figure 1. The more positive response of students to learning after implementing the blended-PBL is in line with some of the previous reports. Some studies report that PBL is learning that can increase student motivation (Chiang & Lee, 2016), as well as in blended learning (Afip, 2014). Therefore, combining both of them could to increase student motivation. Increased student motivation to learn is one indication of an increase in students' positive responses to learning (Lai, 2011).

The results of the blended-PBL response questionnaire in the Cell Biology course were seen from 6 aspects namely attention, relevance, self-confident, attitudes and student assessment. Attention aspects have increased and are included in the category of "good". The results is in line with previous study that informed students' response to blended learning is in "high" category (Muis & Bahri, 2018). Furthermore, the aspect of relevance shows that blended learning is feasible because it has been supported by advances in information and communication technology. High response illustrates that blended learning has the potential to increase student participation in learning. In addition, the application of blended learning is in accordance with the conditions in this era. Then, student responses to aspects of information literacy in the "good" category although there has not been a significant increase. Students are used to using ICT in daily life but are not yet accustomed to learning that integrated with ICT. Students assess that blended-PBL can improve communication and interaction and practice the ability to think critically in solving problems.

The results of the analysis of students' attitudes towards blended-PBL showed that the implementation of this learning responded positively by students. The positive attitude of students towards the implementation of blended-PBL is likely due to the combination of the two learning models so that they can motivate and provide satisfaction with the learning undertaken. This is reinforced by previous research that revealed that the implementation of blended-PBL can improve student motivation, cooperation, and orientation in the learning

process (Woltering, Herrler, Spitzer, & Spreckelsen, 2009). This study is strengthened by other studies that reveal that the implementation of PBL combined with blended learning in learning can improve students' positive perceptions (Dewi, 2013).

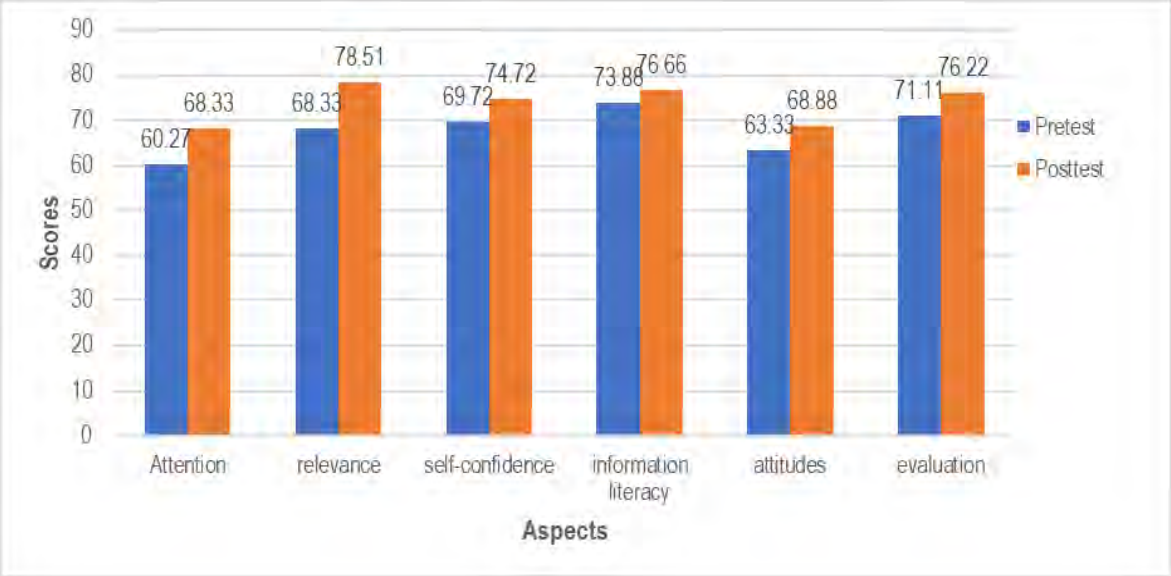

Figure 1. Student responses related to the implementation of cell biology lectures with Blended-PBL

In line with the increase in students' positive responses, their CTS also increased after the blended-PBL was implemented. The results of the scoring of the CTS test that have been carried out in this study are presented in Figure 2. Based on Figure 2, the frequency of students who get a low score has decreased after the blended-PBL is applied. Conversely, the frequency of students who get high scores has increased. Before blended-PBL was applied, 97.01% of students received a low score and only 2.99% received a high score. These conditions change after blended-PBL is applied. The frequency of students who received low scores decreased to 47.4%, while those who received high scores increased to 52.60%.

Figure 2. The frequency of CTS students in cell biology courses before and after blended-PBL was implemented

When examined in more depth, the systematic way of thinking contained in the student's answer sentences has also undergone a change. One example of the questions asked aimed at accessing student CTS in this study is as follows:

"*In the nucleus of the cell there are two important nucleic acids namely DNA and RNA. In the medical world, DNA is used to determine kinship relationships such as determining the relationship between father and son.*

Based on this explanation, can RNA also be used to determine kinship? Then, describe the structural differences in DNA and RNA and explain the functional relationship of the two nucleic acids!"

Examples of students' answers in answering these questions before the blended-PBL implementation are presented in Figure 3. Figure 3 shows that before the application of blended-PBL, the student's thinking process tends to be unstructured. It appears from the answers presented not accompanied by valid reasons. Students actually understand the context of the question (based on the accuracy of student responses/marked with green, red and blue boxes). However, students do not know the reasons that support or reject the answer. In this case students are weak in providing further explanation which is one aspect of critical thinking.

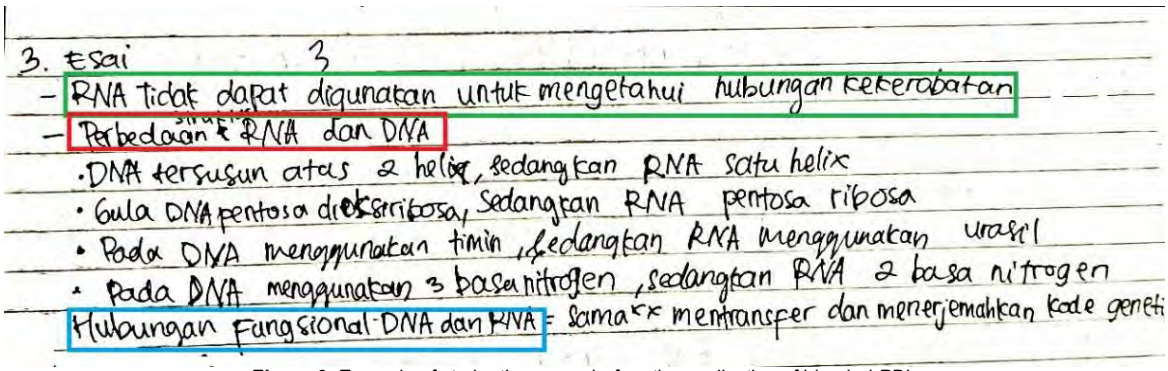

Figure 3. Example of student's answer before the application of blended-PBL

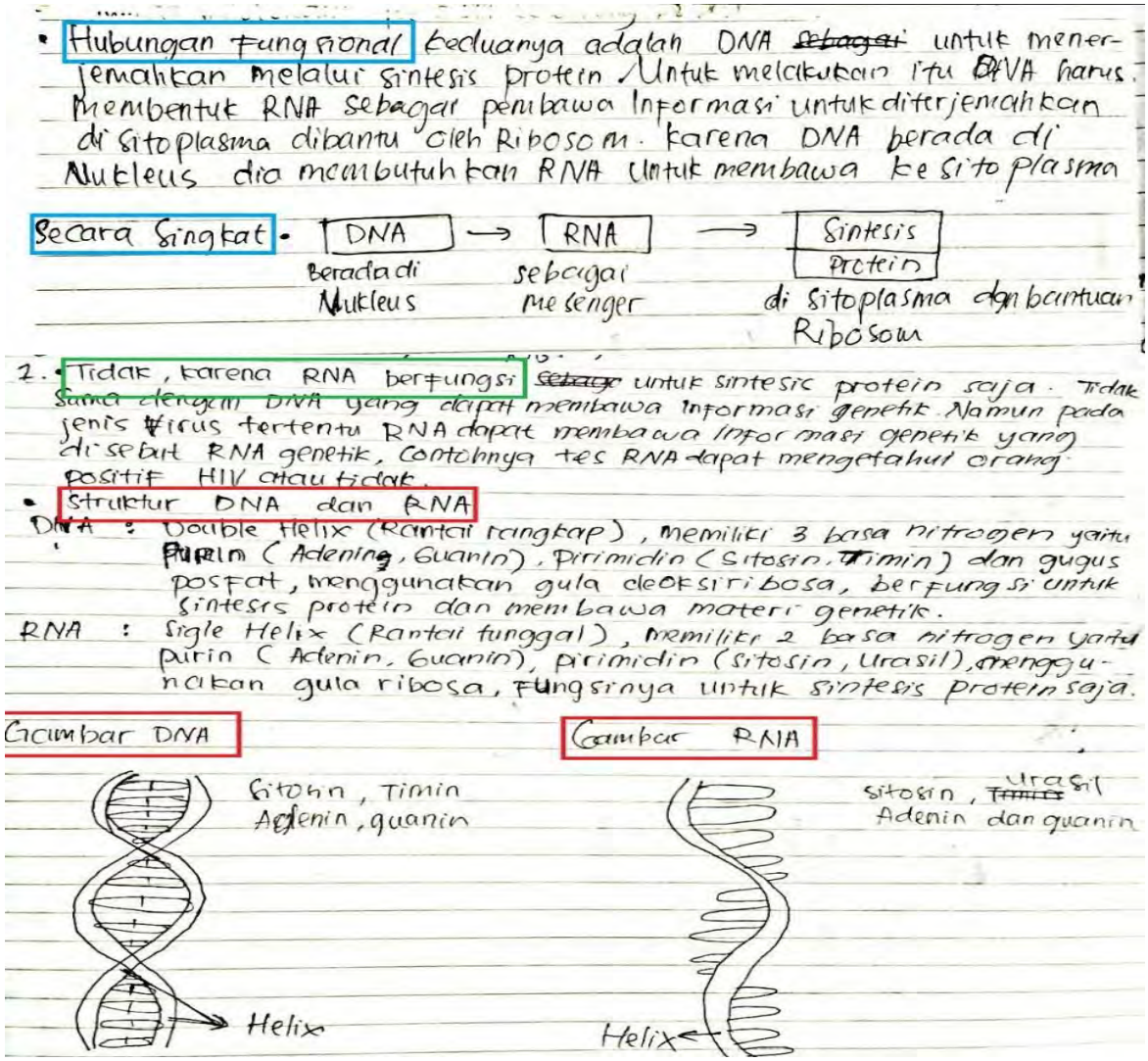

Figure 4. Example of student's answer after the application of blended-PBL

Next, the examples of student answers after following the blended-PBL are shown in Figure 4. Figure 4 shows students have been able to draw conclusions based on assumptions along with the right reasons in correlating the answers according to the previous statement. This condition was supported by the results of interviews which stated that students claimed to have understood the context of the questions as evidenced by the explanation of coherent answers. However, the results is not in line with one previous study that inform blended learning could not significantly improve CTS of students at Department of Computer and Instructional Technology Education in Turkey (Akyüz & Samsa, 2009). The difference between the findings from that study with the present study is possible due to the combination of blended learning with PBL that implemented in this present study. Related to the statement, PBL is reported as one of cooperative learning that can empower students' CTS (Gholami et al., 2016; Yew & Goh, 2016). In this regards, PBL is a recommended to be combined with blended learning to improve the effectiveness of learning in empowering students' thinking skills (Haghparast, Nasaruddin, & Abdullah, 2014).

Through the application of PBL, students are given the opportunity to get used to solving problems. In PBL, problems will always be presented by the teacher at the beginning of each lesson. Such learning is proven to be effective in improving students' analytical skills (Belecina & Ocampo, 2018; Ramdiah, Mayasari, Husamah, & Fauzi, 2018). Through PBL, students will also be directed to be accustomed to inferring the findings obtained after they collect information or supporting data. Such habituation can also train students' skills in solving various problems through a scientific approach (Krishnan, Gabb, & Vale, 2011; Masek & Yamin, 2011). In line with this statement, PBL was also said could to improve students' ability to construct their knowledge through investigation (Akcay, 2009; Marra, Jonassen, & Palmer, 2014)

Practicing critical thinking by addressing problems through the PBL method which is then discussed online provides an opportunity for students to understand the material better. Likewise, in the answers to the results of the post-test it appears that students can provide clarification and then look for and match the appropriate answers to then be concluded correctly. These characteristics as stated Ennis (2011) that the ability to think critically can be reviewed by clarification and seek and assess the truth of information to be concluded.

The role of online discussions conducted through GC is providing comfort condition during learning. Students who have a tendency to lack confidence to ask questions or express opinions in class can be more confident to express it in the GC. Examples of activities carried out in Gc can be seen in Figure 5.

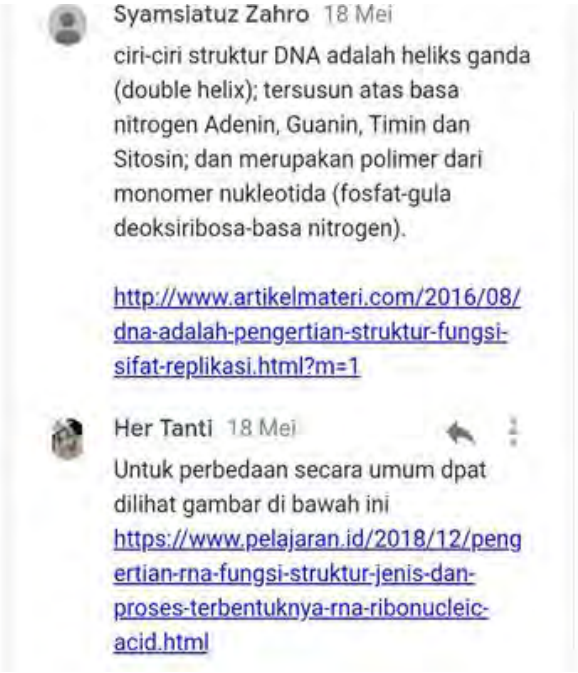

Figure 5. Student discussion page during learning genetic material topic in GC platform

The discussion held online in GC (as shown in Figure 5) provides a space for students to think when examining the opinions of their friends. The implementation of the blended-PBL makes students have wider opportunities especially the quantity of time so they have the opportunity to study at any time. The statement is line with some references that underlines with blended learning students can learn anywhere and anytime (Atef

& Medhat, 2015; Lalima & Dangwal, 2017). This condition will overcome the weaknesses of PBL where PBL is often considered difficult to implement because of the limited time allocation of face-to-face learning (Blackwell & Roseth, 2018; Marta, 2011; Roberto & Ribeiro, 2011).

Moreover, learning by utilizing ICT is reported able to increase teaching and learning processes (Sangrà & González-Sanmamed, 2010). Student ability to analyze the problem was also could be improved because they try to analyze problem during online discussion. Furthermore, students indirectly look for appropriate learning resources to support their understanding (Haghparast et al., 2014). This statement is in line with the other study that reported the learning activities supported by internet media can improve students' thinking skills (Corso & Robinson, 2013).

Other studies also reported that the application of blended learning can improve learning experiences and learning outcomes (Wai & Seng, 2014). Various studies also reported the benefits of applying blended learning in increasing the effectiveness of several cooperative learning (Adnan & Bahri, 2018; Haghparast et al., 2014; Husamah, 2015). Not surprisingly, blended instruction is also considered as innovative learning that can help students improve their performance (Vernadakis, Giannousi, Derri, Michalopoulos, & Kioumourtzoglou, 2012). Therefore, in order to improve the quality of learning in Indonesia, both Indonesian teachers and lecturers must also be able to design this kind of learning.

CONCLUSION

Based on the results of the study, students' CTS could be improved after the implementation of blended-PBL. Further analysis shows that before the implementation of the blended-PBL, students were not able to identify terms, consider definitions, and were unable to provide further explanation. In addition, students have difficulty in drawing conclusions from the discussion so that they cannot apply the concepts to different problems. After implementing the blended-PBL, students are able to develop their critical thinking skills so that they can provide simple explanations, build basic skills, provide further explanations, determine problem solving actions and can draw conclusions correctly.

In connection with the findings obtained, further research needs to be conduct with a wider number of samples and material coverage to get a more comprehensive information about the effectiveness of blended-PBL. In addition, further research is also expected to develop ideal blended-PBL framework and prepare a platform that supports the learning process according to the needs of the 21st-Century.

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