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BPBL (BLENDED-PROBLEM BASE LEARNING) ON EXTRACTION AND CHROMATOGRAPHY MATERIALS USING COFFEE TOPICS TO MEASURE STUDENT LEARNING OUTCOMES AND SOFT SKILLS

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ABSTRACT

Abstract: Research and development of the BPBL's teaching materials (Blended-Problem Base Learning) aims to measure its effectiveness on students learning outcomes (in extraction and chromatography courses) and their soft skills . Based on the preliminary questionnaire regarding the need for development of the BPBL's teaching materials states that the students felt quite difficult to understand the concepts in extraction and chromatography so their learning outcomes does not meet the standards. Students also realize that improving their soft skills is important for personal development, social participation, and success in the work environment. BPBL's teaching materials is a combination between blended learning and problem base learning. Using coffee as daily content is used to give meaningful learning for students and aim them to easily understand the concept in extraction and chromatography courses. The effectiveness of BPBL's teaching materials on learning outcomes of students with n-gain is 0.64 or 64% and the effectiveness on soft skills of students with n-gain is 0.31% or 31%, both are included in the medium effectiveness category.

INTRODUCTION

The Blend-Problem-Based Learning (BPBL) learning model combines Blended Learning and Problem-Based Learning. Blended Problem Base Learning (BPBL) (Donnelly., R., 2006), Problem-Based Hybrid Learning (Pro-BHL) (Sujanem, R., S. Poedjiastuti., B. Jatmiko., 2017), and Problem Based Blended Learning (PBBL) are examples of the combination of Blended Learning with Problem-Based learning that has been studied (Wannapiroon, P., 2008). The combination of the two pedagogical approaches resulted in the development of the Blended Problem-Based Learning method. Both strategies are incorporated into constructivist learning theory (Donnelly., R., 2006). Dewey demonstrated that learning might begin with a problem (problem-based learning) in order to stimulate students' interest in finding solutions to issues. In the meantime, according to Vygotsky, the supply of learning facilities can enhance the cognitive abilities of pupils with specific objectives (Carlson, JS, 2013). In contrast, blended learning involves the use of technology for both face-to-face and virtual learning. The BPBL model's learning components are detailed in Table 1 (Wannapiroon, P., 2008):

Table 1. Learning Components of the BPBL Model

BPBL Model		
Component	Sub components	Details
1. Establish the principles of the BPBL model	• Blended Learning System	Website, F2F, e-learning
	• Stages of Problem Base Learning	According to reference
	• Activities to improve the desired aspect/result	In accordance with the RPP
	• Interaction process	Learner-learner, learner-instructor, learner-content, learner-interface
	• Student regulations	As a facilitator, providing feedback, monitoring learning activities, providing advice and input, as a motivator and

BPBL Model		
Component	Sub components	Details
		providing summative and formative values
	● Student regulations	Participate in F2F learning, e-learning, websites, follow each stage of PBL and group discussions.
	● Support sources on the website	Presentation tools, communication tools, online reference resources
2. Setting the goals of the BPBL learning model		According to the needs
3. Stages of learning the BPBL model	● Preparation stage	Orientation, practice, group formation, pretest
	● Learning stages	According to the PBL stage
4. Learning Evaluation	● Final test	In accordance with the goals set

Source: (Wannapiroon, P., 2008) .

Individual and group learning outcomes are the outputs produced from the learning process (Paolini, A., 2015). Learning outcomes can be evaluated either summatively or formatively (Coates, H., 2015). Ten students at the State University of Malang who have taken lectures on extraction and chromatography and who were given a questionnaire about the need to develop BPBL-based teaching materials stated that they frequently find it difficult to understand the concepts of extraction and chromatography material. As a result, the learning outcomes on the material extraction and chromatography did not meet the passing grade standard. In addition, based on the preliminary survey, the majority of students recognize the significance of developing soft skills. (Kechagias, K. (editor), et al., 2011) define soft skills as intra and interpersonal talents (social emotions) that are crucial for personal development, social involvement, and success in the workplace. In China, Yan et al. did research on the importance of equipping students with soft skills in addition to hard abilities in order to prepare them for the rapid, dynamic, and unpredictable changes in the world (Yan, I., et al. , 2018). Multiple colleges equip their students with both hard and soft skills that support their jobs and help to the discovery of novel solutions to social challenges (Whiteside, et al., 2017). Technology is one method of delivering learning with the BPBL approach. As a component of blended learning, technology can enhance students' soft skills and learning outcomes in pursuit of meaningful and lifelong learning (Stal, J & Grazyna PP, 2018). Table 2 illustrates the coverage of soft skills.

Table 2. Soft Skill Coverage

Soft Skills		
Personal Development	Social Skills	Work environment
Make decision	Communication skills	Adaptability and flexibility
Solve the problem	Teamwork	Motivation
Creativity and Innovation	Conflict management	Responsibility setting
Critical and structured thinking	Ability to serve	Timing

Source: (Ducange, C., et al., 2016).

Frequently, chemistry learning materials contain difficult-to-grasp abstract concepts; therefore, a more concrete concept approach is required. The incorporation of student activities might boost motivation and interest in chemistry study (Woldeamanuel, MM, Harrison A., Temechegn E., 2014). Extraction and chromatography materials are included in the Chemical Separation course at the State University of Malang, which is the bridge between Basic Analytical Chemistry and Contemporary Analytical Chemistry (Wonorahardjo, S., 2013). In materials on extraction and chromatography, students are expected to comprehend numerous extraction and chromatography procedures, including parameters and fundamental ideas. Coffee is one of the benefits of understanding the extraction of a component from its matrix and identification via chromatography (Wonorahardjo, S., 2013). Learning that highlights a real-world problem, such as using coffee content, makes learning more engaging and enhances student involvement in the learning process (Stockwell, BR, Stockwell, MS, Cennamo, M., & Jiang, E., 2015). Following is a framework for research and development of BPBL-based instructional materials to assess their impact on student learning outcomes and soft skills in extracting and processing materials utilizing coffee content.

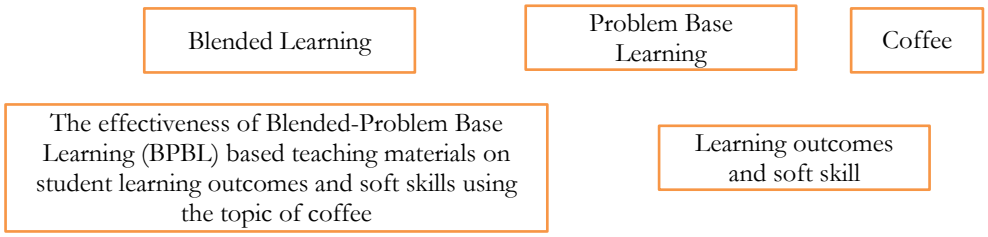

Figure 1. Framework for Research and Development of BPBL-Based Teaching Materials

METHOD

The research and development method of BPBL-based teaching materials employed an R&D design adapted from Plomp with five research phases, notably: (1) the initial investigation phase includes problem analysis and needs analysis by analyzing information, defining problems, and designing work projects; (2) the design phase includes the stages of designing a solution with a written or work plan which will then be implemented in the construction phase; (4) the construction phase includes prototyping and testing; and (5) the evaluation phase includes evaluating the effectiveness of the solution. According to Plomp (Plomp, Tj., 1997), the five phases are useful for tackling a common problem in education, which was subsequently condensed into three phases in research and development:

1) Initial phase (Preliminary research) .

The initial phase consists of 3 stages:

(a) Needs and context analysis. Needs and context analysis for the production of BPBL-based instructional materials utilizing a preliminary online survey emailed to students who have previously taken Chemical Separation courses on extraction and chromatography topics. The calculation of the percentage of whether or not it is necessary to construct BPBL-based teaching materials based on the validator's evaluation and suggestions using the Likert scale as shown in Table 3 and the scoring provided in Equation 1 (Akbar, S., 2016).

Table 3. Assessment Criteria Rubric

Score	Criteria
1	The answer is not necessary / not at all / very high score
2	Answers are not necessary/somewhat often/high score
3	Answers are quite necessary/quite often/sufficiently low score
4	Answers need/often/low score
5	Answer is very necessary/very often/very low score

Source: (Sugiyono, 2015)

$$\%\ \text{keperluan pengembangan} = \frac{\sum \text{skor yang diperoleh}}{\sum \text{skor maksimal}} \text{ x } 100\% \quad (1)$$

(b) Literature review. This stage examined BPBL-based teaching materials in accordance with the literature, reviewing the content of the information to be provided, and reviewing sources for learning about coffee-related extraction and chromatography constituted the literature review.

(c) Construction of a conceptual and theoretical framework. The purpose of this stage is to establish a conceptual and theoretical framework for the components and phases of learning utilizing BPBL-based teaching materials according to stages (a) and (b) (b).

2) Prototyping Phase

In the prototype phase, the design of BPBL-based teaching materials was carried out with research instruments, namely validator assessment questionnaires, preliminary questionnaires for research and development of BPBL-based teaching materials, student readability questionnaires, lesson plans, initial and final test questions and soft skills questionnaires. At this stage, the validation of BPBL-based teaching materials and validation of research instruments are carried out. Validity is a measure to show the level of validity of an instrument. The instrument is said to be valid if the interpretation of the instrument is able to measure the objectives in the study (Creswell, JW, 2012) . Content validation is very important to show how deep the items cover the material discussed (Azwar, A., 2012) . Content validation includes assessment of teaching materials based on BPBL and research instruments carried out with the help of expert judgment , namely expert lecturers at the State University of Malang (2 people).

The validator's assessment and suggestions follow the Linkert scale as shown in Table 3 with the provision of scoring in equation 2 (Akbar, S., 2016).

$$\% \text{ validasi isi} = \frac{\sum \text{skor yang diperoleh}}{\sum \text{skor maksimal}} \text{ x } 100\% \quad (2)$$

3) Phase (Assessment Phase)

In the third stage is the assessment phase where after the BPBL-based teaching materials and supporting instruments are declared valid, (a) readability tests are carried out and (b) the effectiveness of BPBL-based teaching materials were tested. The readability test was carried out by ten students who had taken chemical separation courses, media experts and material experts. The readability analysis employed the Likert scale (Akbar, S., 2016) as shown in Table 3, and the percentage of readability can be seen in equation 3.

$$\% \text{ keterbacaan} = \frac{\sum \text{skor yang diperoleh}}{\sum \text{skor maksimal}} \text{ x } 100\% \quad (3)$$

To test the effectiveness of BPBL in learning, it enrolled an experimental class with a pre-experimental design with pre-test and post-test (Ibnu, S., Mukhadis, A., & Dasna, IW, 2003). The variables measured were learning outcomes through pre-test and post-test as well as student soft skills through self-assessment questionnaires and judgment assessment questionnaires. To test the effectiveness of the research and development of BPBL-based teaching materials, one pre-experimental class is used as shown in Table 10 with 29 students.

Table 4. Research Design and Development of BPBL-Based Teaching Materials

Class	Experiment		
	Before	Treatment	After
R	O1	X	O2
	P1		P2

Adapted from (Ibnu, S., Mukhadis, A., & Dasna, IW, 2003)

Information:
O1 : Pre-test subject
O2 : Post-test subject
P1 : Self-assessment questionnaire
P2 : Judgment assessment questionnaire
X : Treatment using BPBL-based teaching materials
R : Subjects who were given treatment

The normalized gain test was used to measure the effectiveness of BPBL-based teaching materials on student learning outcomes and soft skills. The normalized gain (N-gain) can be calculated by equation 4 (Meltzer ., 2002):

$$G = \frac{\text{Sposttest} - \text{Spretest}}{\text{Smaksimum} - \text{Spretest}} \text{ x } 100\% \quad (4)$$

Information :
G : normalized gain (N-gain)
Smaximum : the maximum score from the initial test and the final test
S pre-test : initial test score
S post-test : final test score

N-gain criteria are interpreted based on the following Table 5:

Table 5. Criteria for Grouping *N-gain*

of N-gain effectiveness interpretation	
Range	Category
N-gain > 0.7	Tall
0,3 ≤ N-gain ≤0.7	Currently
N-gain < 0.3	Low

Source: (Meltzer in Syahfitri 2008:33)

Before determining the N-gain value, the data was tested for normality and paired sample t-test to determine whether the sample data was normally distributed and whether there was a difference in student learning outcomes and soft skills , before and after using BPBL-based teaching materials. Analysis of normality test data (Lilliefors, HW, 1967) and paired sample t-test using SPSS version 17 program.

RESULTS AND DISCUSSIONS

Data on the results and development of BPBL-based teaching materials following the R&D development stage according to Ploomp which has been simplified are as follows:

1) Initial phase (preliminary research)

(a) Needs and context analysis.

The results of the preliminary on-line research questionnaire can be seen in Table 6.

Table 6. Student On-line Preliminary Questionnaire

No.	On-line questionnaire topic	Percentage	Interpretation
1.	student learning outcomes on extraction and chromatography materials	71.67%	It is necessary to develop BPBL-based teaching materials for extraction and chromatography materials
2.	student soft skills	84.00%	It is very necessary to develop BPBL-based teaching materials to develop student soft skills

Based on table 6, the percentage of questionnaire scores regarding student learning outcomes on extraction and chromatography materials is 71.67% or in other words it is necessary to develop BPBL-based teaching materials to improve learning outcomes on extraction and chromatography materials. Meanwhile, the value of the questionnaire regarding student soft skills is 84.00% or in other words, it is very necessary to develop BPBL-based teaching materials to improve student soft skills .

(b) Literature review.

This research includes a literature review. Coffee, extraction and chromatography, learning outcomes, and soft skills must be researched utilizing the BPBL model. Wannpiroon's BPBL model's stages (2008). Literature study on coffee extraction and chromatography involves extracting coffee constituents using different procedures and evaluating coffee's authenticity with chromatographic instruments. Hmeleo (2004)'s PBL prototype phase guides the PBL literature review. Students' cognitive thinking can be honed via challenging issues. Literature study of Kechagias (2011) instrument to test soft skills comprises self-evaluation and judgment assessment.

(c) Development of conceptual and theoretical framework:

BPBL combines blended and problem-based learning. Blended learning components include facilities and infrastructure for extracting and chromatographing coffee-related difficulties. Several extraction and chromatography techniques and theories can be examined, such as reducing coffee's caffeine level and testing for coffee fraud. Real events are broadcast through virtual media to provide pupils real-world difficulties to solve. According to Aidoo et al. (2016), giving issues promotes student learning since they learn to apply scientific knowledge to real-world circumstances. Prototype describes PBL steps that help students develop soft skills.

2) Prototype phase (prototype phase)

In the prototype phase, the design of BPBL-based teaching materials was carried out with research instruments and their validation. BPBL-based teaching materials consist of websites with PHP and MySQL programming languages as learning instrument (in this research and development included in the CMS website (Content Management System). The BPBL website consists of animated videos about coffee and MFIs with PBL stages. Learning Process Flow with PBL adapted from Hmelo, C. E & Silver (2004) as follows:

- Phase 1: Problem topic
  At this stage the student defines the problem given
- Phase 2: Identify facts
  At this stage, students describe the latest facts related to the problem and relate them to facts that students already know before.
- Phase 3: Hypothesis
  At this stage, students pour an idea map to develop a solution
- Phase 4: Simplification of knowledge
  At this stage students work with their groups to discuss solutions to the problems posed. Students divide work assignments with fellow group members and record their respective activities which are then summarized in possible solutions.
- Phase 5: Application of new knowledge

At this stage, students choose the best solution based on the results of the discussion

- Phase 6: abstraction
  Students present the results of group discussions to other groups. Other groups can question other groups' answers in the WhatsApp discussion forum
- Phase 7: Evaluation
  Students try to work on several evaluation questions to measure the success of understanding the material related to the problems previously proposed. The teacher provides conclusions and evaluates the results of the learning process that has been carried out and conveys it to students through discussion forums

For interaction tools between teachers and fellow learners using Google meet for the face-to-face interaction process or F2F (face to face) virtually and the WhatsApp application as a means of group discussion. According to research conducted by Anggraini (2016), conducting virtual discussions increases the comfort and confidence of students in expressing their opinions. Activities to improve aspects of soft skills are:

- Preparation stage
  sub-indicators of soft skills developed are adaptation and flexibility, motivation, time management, team work, conflict management and service ability.
- Stages of learning with PBL
  sub-indicators of soft skills developed are adaptation and flexibility, motivation, team work, service skills, communication skills, problem solving, conflict management, responsibility management, time management, creativity and innovation, critical and structured thinking.
- Final test
  sub-indicators of soft skills developed are time management, critical and structured thinking, problem solving.

In this prototype phase, validation was also carried out on the BPBL-based teaching materials developed and the research and development instruments used. The results of the validation of the developed BPBL-based teaching materials and research and development instruments can be seen in Table 7.

Table 7. Results of Validation of Research Instruments by Material Experts

No	Instrument	Material expert I	Material expert II	Average validation percentage	Interpretation
1.	Preliminary Questionnaire on-line	82.22%	77.78%	80.00%	Very high
2.	BPBL-based teaching materials	82.50%	70.00%	76.50%	Tall
3.	RPP BPBL	73.33%	83.33%	78.33%	Tall
4.	Pre-test sheet	60.00%	62.50%	61.25%	Tall
5.	Post-test sheet	80.00%	62.50%	71.25%	Tall
6.	Pre-test rubric	73.33%	80.00%	76.67%	Tall
7.	Post-test rubric	86.67%	80.00%	83.33%	Very high
8.	Soft skill questionnaire (self-assessment questionnaire and judgment assessment questionnaire)	86.67%	50.00%	68.33%	Tall
9.	Soft skill rubric (self assessment rubric and judgment assessment rubric)	86.67%	60.00%	73.33%	Tall

Based on table 7, the average validation value ranges from 61.25 to 83.33 percent. According to the interpretation of the validation findings criterion, the range of 60 to 80 percent is high, whereas the range of 80 to 100 percent is extremely high. The validation results show that BPBL-based instructional materials and research and development tools can be utilized in the next step of assessment.

3) Assessment phase (assessment phase)

The experimental class was utilized to test validated BPBL-based teaching materials and research development instruments. The findings of testing BPBL-based teaching materials indicate that students are eager and passionate about participating in learning with the BPBL paradigm utilizing the theme of coffee. This evaluation process is separated into two stages: the readability test and the effectiveness test.

(a) Readability test
The results of the readability test can be seen in Table 8 where the average total readability value of the BPBL is 76.40%. This means that the BPBL can already be used for the next stage with minor improvements.

Table 8. Results of the Readability of BPBL-based Teaching Materials

No.	Instrument	Average score of media expert (I & II)	Average score from material expert (I & II)	Average grades of students
1.	BPBL-Based Teaching Materials	77.86%	69.05%	82.29%
Average readability			76.40%	

(b) Test effectiveness

After the readability test was completed, the BPBL-based teaching materials effectiveness test was carried out to measure their effectiveness on student learning outcomes and soft skills.

Normality test

The normality test of learning outcomes data through pre-test and post-test can be seen in table 9, as well as for the normality test of soft skill value data can be seen in Table 9 as follows:

Table 9. Normality Test of Student Learning Outcomes and Soft Skills

Variable	n	Kolmogorov-Smirnov Normality Test Significant		Conclusion
Learning outcomes	29	Pre-test 0.977	Post-test 0.260	Normal
Soft skills	29	Self-assessment 0.835	Judgment assessment 0.695	Normal

In table 8, the significant value pre-test is 0.977 and post-test is 0.260. This shows that the pre-test significant value > 0.05 or 0.977 > 0.05 and the post-test significant value > 0.05 or 0.260 > 0.05, hence the research sample test results were normally distributed. In table 8, the self-assessment significance value is 0.835 > 0.05, thus the data is normally distributed. Self-evaluation and judgment assessment data are normally distributed if sig.2 tailed > 0.05.

Paired Sample t-test

The paired sample t-test test on the data on the value of learning outcomes through the pre-test and post-test can be seen in Table 10, as well as the paired sample t-test on soft skill value data can be seen in Table 10 as follows:

Table 10. Paired Sample t-test on Student Learning Outcomes and Soft Skills

Variable	n	Paired Sample t- Test Significant	Conclusion
Learning outcomes	29	Posttest-Pretest 0.000	There is influence
Soft skills	29	Self-assessment-Judgment assessment 0.000	There is influence

The paired sample t-test in Table 10 shows a significant value (sig. 2 tailed) for pre-test and post-test of 0.000 0.05, showing that employing BPBL-based teaching materials affects student learning outcomes on extraction materials and chromatography.
In Table 10, the significant value (sig. 2 tailed) of self-evaluation and judgment assessment is 0.000 0.05, which means Ho is rejected and Ha is accepted, which means utilizing BPBL-based teaching materials affects students' soft skills in extraction and chromatography learning.

N-gain test

The data obtained from this stage can be seen in Table 11.

Table 11. Effectiveness of BPBL-Based Teaching Materials on Learning Outcomes and Soft Skills

	Learning outcomes			Soft Skills		
	Pre-test	Post-test	N-Gain	Self-Assessment	Judgment Assessment	N-gain
mean	58.53	85.78	0.64	53.38	69.18	0.31
variance	124.34	71.03	0.04	150.44	41.35	0.03

	Learning outcomes			Soft Skills		
	Pre-test	Post-test	N-Gain	Self-Assessment	Judgment Assessment	N-gain
SD	11.15	8.43	0.21	12.27	6.43	0.17
n	29	29	29	29	29	29
Maximum	80.00	97.50	0.90	70,80	81.30	0.70
Minimum	40.00	60.00	0.00	22.90	54.20	0.06
Range	40.00	37,50	0.94	47,90	27.10	0.65

CONCLUSION

The development of BPBL-based instructional materials utilizing coffee in extraction and chromatography can enhance student learning outcomes (0.64 or 64 percent effectiveness) and student soft skills (0.31 or 31 percent). Both elements contribute to the mediocre effectiveness. In addition to requiring a reliable Internet connection, BPBL-based instructional materials require additional study time to maximize their effectiveness.

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