RESEARCH ARTICLE

Promoting student's habits of mind and cognitive learning outcomes in science education

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Abstract: Learning must be able to develop knowledge, skills, and mindsets so that the graduates produced have attitudes, abilities and knowledge that are integrated and skilled in life. One way to achieve learning can be done through habits of mind because the success of learning is strongly influenced by habits of mind. The purpose of this study is to as certain how habits of mind and cognitive learning outcomes in biology are affected by learning process oriented guided inquiry learning with blended learning support. A pretest-postest design wih a non-equivalent control group was employed in this study. The trial ran from February to June 2022. Utilizing the habits of mind questionnaire, pupils' thought patterns were assessed. Essay tests are also used to evaluate the results of cognitive learning. In this study, google form, LMS, and google meet were used for data collection. Statistical Product and Service Solutions software version 23 is used for data analysis and the results of covariance analysis (ANCOVA) showed a p value < 0,005, meaning that POGIL-supported blended learning can empower habits of mind and cognitive learning outcomes in biology learning. There is a substantial difference between the outcomes of the least significant difference and increasing habits of mind and cognitive learning outcomes. As a result, POGIL with moodle support can be used to enhance students' habits of mind and cognitive learning results in biology classes.

Keywords: biology; blended learning; cognitive learning outcome; habits of mind; process oriented guided inquiry learning

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Introduction

Human resources with the ability to behave and think appropriately are undoubtedly necessary for a nation to develop and make wise judgments. It is then expected of every person with those qualities to be able to overcome a variety of obstacles in her or his daily existence (Ongardwanich et al., 2015). In line with that, in order to meet the demands of 21st century learning, students must develop learning abilities and life skills (Geisinger, 2016; Soule & Warrick, 2015). One of the ability is habits of mind. Initially, the concept of habit of mind began with research in the field of education and brain development. (Alhamlan et al., 2018) revealed that habits of mind are related to behaviors that can be used easily to solve problems. Meanwhile, Costa and Kallick, (2000) explain that habits of mind relate to a set of dispositions that are learned and implemented before completing a particular task. Therefore, some examples of activities that can train habits of mind are by raising problems, training students to take risks that are responsible for the activities carried out, and applying the knowledge they have in new or different situations. When individuals make a decision from a problem faced in everyday life, this is where habits of mind are needed as basic skills to imitate the way scientists think and practice their work (Kalin

& Namdar, 2022).

Habits of mind support students in everyday life because both are a combination of many skills, attitudes, and past experiences (Costa & Kaliick, 2012). Habits of mind can be divided into three categories, namely: self-regulation, critical thinking, and creative thinking (Marzano et al., 1993). Students are expected to do regulation in thinking (Padmanabha, 2020). One of the most crucial fundamental skills and a sign of human growth is the capacity for critical thought (Mahanal, 2012). Critical thinking is crucial since it is a necessary talent for making judgments and coming up with answers to issues (Alsaleh, 2020). According to Ramalingam et al., (2020), creative thinking is the capacity to generate original, high-quality ideas as ell as the ability to critically analyze and reinterpret a situation. To build exceptional problem solving skills, learning activities that strengthen mental habits such as a person's beliefs and understanding of thought processes are essential (García et al., 2015). Habits of mind plays an important role in the ability to think and solve problems because the first step in solving actual problems is to think about the consequences of problems solved (Noreen et al., 2015).

Unfortunately, the empowerment of habits of mind in learning is still not (Gloria et al., 2017; Marita, 2014). Survey results in 2019 show that students have habits of mind with sufficient criteria, but three indicators have a percentage below 70%, namely managing impulsivity, questioning and raising problems, and thinking and communicating clearly and precisely (Ariyati et al., 2020). This proves that efforts are still needed to develop habits of mind by accustoming students to take wiser and smarter actions when facing problems/tasks.

Students' thinking habits need to be improved in learning to make it easier for students to learn. Science learning requires the ability to think intelligently to understand natural phenomena according to the content or material being studied, for example the ability to collect evidence/information, explain, or present scientific concepts in new situations (Janssen et al., 2009). Habits of mind helps students use their time productively and hone their intelligence, making it easier to follow the learning process and wanting to continue learning (Isfiani, 2016). Habits of mind is able to develop individual skills and self-regulation, improve, develop and modify knowledge and cognitive abilities (Adams, 2006; Costa & Kallick, 2000). Students who have habits of mind are able to develop plans to solve problems and systematically test solutions (Costa & Kaliick, 2012). According to Coley & Tanner, (2015) added that habits of mind helps overcome misconceptions and master concepts well, thereby improving learning outcomes (Idris et al., 2014; Qadarsih, 2017).

Cognitive learning outcomes consist of remembering, comprehending, applying, analyzing, evaluate, and create (Zorluoğlu & Güven, 2020). Concept mastery is the term used to describe this, which may be seen as the ability to illustrate linkages between concepts and use them to solve issues in daily life (Nieto-Márquez et al., 2020; Zorluoğlu & Güven, 2020). In scientific education, cognitive learning outcomes are important because they help students develop good character traits and critical thinking skills (Prachagool & Nuangchalerm, 2019). In addition, goods and product standards learning development are considered cognitive learning outcomes (Adom et al., 2020). Cognitive talents should prioritize reasoning, applying acquired knowledge, putting it into your own words, drawing comparisons, and coming up with original ideas. If these requirements are met, kids may absorb knowledge, think critically about it, and grasp it completely. Cognitive learning outcomes in scientific learning are currently still confined to aspects recall, comprehend, and apply (Hasnunidah et al., 2019; Ilma et al., 2020). A survey conducted on first year students found the percentage of students' cognitive abilities. Aspect of remembering and understanding respectively obtained 85.21% and 81.46%. Both figures are included in the good category category. The implementation aspect obtained a gain of 61.24%, which is included in the sufficient category. Aspects of analyzing, evaluating, and creating respectively obtained results of 36.25%, 37.08%, and 36.25% which were included in the poor category. Therefore, the development of higher-dimensional cognitive skills is necessary.

Observations made on the implementation of general biology lectures for students in the mathematics and science education department at Tanjungpura University showed that not all students actively participated in learning, understanding of biological concepts still varied, and the learning strategies used were still limited to discussion and assignment methods. Meanwhile, biology as part of today's science learning should be able to prepare future generations to be skilled in thinking, master the material well, have skills in technology, and be enthusiastic (Howard, 2018). It is therefore necessary to formulate a suitable model or method of learning. The solution to the above-mentioned problems, such as habits of mind and cognitive abilities, is the Process Oriented Guided Inquiry Learning (POGIL) with Blended Learning (BL) and moodle.

POGIL is a process-oriented collaborative-constructive learning, centered on the student through guided inquiry activities and cooperative approaches (Gale & Boisselle, 2015; Hanson, 2007; Rege et al., 2016; Trevathan et al., 2014). Inquiry-guided learning in POGIL actively involves the student and encourages them to restructure information and knowledge using a learning cycle consisting of five stages: orientation, exploration, conceptual formulation, application, and closure (Hu et al., 2016). In addition to POGIL effectively improving students' high-level thinking skills, improving critical-thinking skills, problem-

solving skills, communication, collaboration, and self-reliance skills (Haryati, 2018; Jaffe et al., 2015; Pradiyanasari et al., 2020; Soltis et al., 2015) it is necessary to strengthen 21st-century competencies in an information age that is identical with Information Technology and Communication, namely Blended Learning (Zurita et al., 2015). Research results show Blended Learning can stimulate smart thinking habits, correct misconceptions and improve concept mastery (Howard, 2018). The use of Blended Learning can express and develop critical thinking as well as enhance problem-solving skills (Adom et al., 2020; Haryati, 2018). Some studies have also integrated POGIL with blended learning, but studies that integrate POGIL and Blended Lerarning with their influence on habits of mind and cognitive abilities in students are still rare. Therefore, the aim of this study is to analyze the impact of POGIL assisted Blended Learning on both of these capabilities.

Method

Research design

The research applied quasi-experimental with pretest-postest non equivalent control group research design as shown in Table 1. Independent variables included the POGIL assisted Blended Learning (POGIL-BL) and Conventional Learning (CL) implemented in two treatment classes. They consist of 60 student first year students taking general biology courses in the mathematics and science education department in Pontianak.

Table 1. Research Design

Pretest	Treatment Group	Number of Student	Posttest
O1	POGIL-BL	30	O2
O3	CL	30	O4

Instrument

Habits of mind questionnaire, and cognitive tests were developed to collect data. The habits of mind questionnaire items were created in collaboration with psychologists and linguists. Researchers also worked with education and biology experts to develop cognitive test items. The habits of mind questionnaire consist of 3 categories, according to Marzano (Hayat et al., 2019); namely (1) self-regulation, (2) critical thinking, and (3) creative thinking, each of which has three items. The validity test results for the habits of mind questionnaire were declared valid with a value of 0.478. The cognitive test consists of 10 essay questions. That Instrument validity and reliability tests were carried out using Pearson Product Moment, and Reliability testing was carried out using Cronbach's Alpha. The results of the validity test for the cognitive test instrument were stated to be valid with a value of 0.564 and reliable with a value of 0.818.

Procedure

The course lasts one semester and consists of three stages (Figure 1). First, the preparatory stage consists of: (1) group formation; (2) an explanation to participants of the research objectives, assessments, and rules during the course of learning; and (3) conducting pre-tests. Second, the development stage involves planning strategies and learning topics. (including student worksheets). The POGIL assisted Blended Learning (POGIL-BL) and Conventional Learning (CL) stages are presented in Table 2 and Table 3. Topics/materials studied by students are considered based on learning outcomes in the applicable curriculum. There are four topics that are studied: (1) exploring life, (2) genetics, (3) ecology, and (4) biodiversity. Third, the post-test is carried out once all the materials and learning activities are over.

Table 2. Stages of POGIL-BL

Phase	Student Activities
Preparation and Orientation	observe pictures/videos, write conclusions from the observed images/videos
Exploration	conducting exploration activities based on guidelines in worksheet (Collecting data and information)
Concept Formation	report the results of exploration to form the concept of the topics studied
Application	apply learning to new situations and problems
Reflection and Evaluation	evaluate learning performance, what has been obtained and what has not been obtained. Write small notes about the learning process through journal reflection,

(adapted from Hanson, 2007)

Table 3. Stages of CL

Phase	Student Activities
Brainstorming	answer questions and convey opinions, ideas, or experiences
Review the topic/material	sharing and presentation of material already studied
Develop question and discussion	convey opinions/ideas or thoughts, ask questions
Elaboratioan and Reinforcement	listen, take notes, or ask questions
Evaluation and Reflection	summarize the material that has been studied, record assignments, and write a reflection journal

(adapted from Suwono et al., 2021)

Data Analysis

Data were analyzed using analysis of covariance (ANCOVA) and least significant different (LSD) with the help of statistical product and service solutions (SPSS) software version 23. Normality and homogeneity were tested first before analysis. Normality test was performed with the One Sample Kolmogorov-Smirnov Test, and homogeneity test was performed with Levene's test. ANCOVA and LSD were performed after the requirements were met to determine the POGIL-BL model's effect on habits of mind and cognitive learning outcomes (Suwono et al., 2021). The LSD test was performed to determine the significance level of the learning model.

Results and Discussion

The result of normality and homogeneity tets of habits of mind and cognitive learning outcomes

It is necessary to run homogeneity and normality tests before evaluating the hypothesis. It is necessary for the data to be homogeneous and regularly dispersed. Table 4 displays the findings of the tests for homogeneity and normalcy of habits of mind and cognitive learning outcomes. Table 4 displays the homogenous and regularly distributed scores for the learning outcomes and habits of mind of the students (level of significance > 0.05). As a result, conducting hypothesis testing might be feasible. To find out how the learning model affected students' habits of mind and cognitive learning results, hypothesis testing was done using ANCOVA.

Table 4. The results of normality and homogeneity tests of students' habits of mind and cognitive learning outcome

Treatment Group	Normality		Homogenety	
	N	Sig.	Score Levene's test	Sig.
Habits of mind pretest	60	0.330	1.271	0.293
Habits of mind pretest	60	0.352	2.253	0.092
Cognitive learning outcome pretest	60	0,200	1.850	0.171
Cognitive learning outcome pretest	60	0.167	1.656	0.178

The effect of POGIL-BL and conventional learning on sudents habits of mind

The effect of POGIL-BL and CL on students' habits of mind was obtained through the ANCOVA results with pretest scores as covariates. The effect of the learning model on students' habits of mind is presented in Table 5. The table presents the differences in the learning model (F count=4.654 with p value=0.035 while the value of $p < \alpha$ (α=0.05). Therefore, the proposed hypothesis was accepted. The learning model affects students' habits of mind. Then, the LSD test was performed. The results are presented in Table 6 shows significant differences between CL and POGIL-BL. It was reflected in the average posttest score.

The average student's habits of mind score was 2.92 for the pretest and 3.50 for the post in the experimental class, whereas in the control class the average pre-test scores were 2.85 and the post 3.26 Figure 1. Based on the data showed that the habits of the mind of students in the experiment class were larger than in the control class. The difference between the pre-test and the post in the experimental class is 0.58 and in the control class 0.41. Further results for each aspect of habits of mind in control class and experiment class in detail can be seen in Figure 2.

Table 5. ANCOVA result (habits of mind/HoM)

Source	*Type III sum of Squares*	*df*	*Mean Square*	*F*	*Sig*
Corrected Model	13.098[a]	2	6.549	13.239	.000
Intercept	26.227	1	26.227	53.019	.000
Pretest HoM	5.383	1	5.383	10.882	.002
Class	5.827	1	5.827	11.779	.001
Error	28.197	57	.495		
Total	6182.111	60			
Corrected Total	41.294	59			

R Squared = .317 (Adjusted R Squared = .293)

Table 6. LSD test results (habits of mind/HoM)

No	Class	Average pretest	Average posttest	Average Corrected	LSD Notation
1.	Experiment	2.92	3.50	3.49	a
2.	Control	2.85	3.26	3.27	b

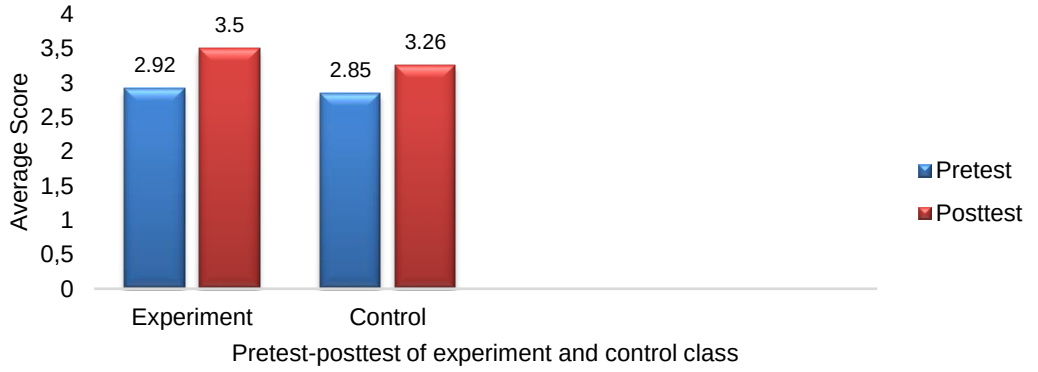

Figure 1. Comparison of average result for habits of mind

Figure 1 showed that there was an increase in habits of mind from pretest to posttest. The research results found that the average habits of mind of students in the experimental class increased from 2,92to 3,5. In the control class habits of mind increased from 2,85 to 3,26. The LSD test results show that the results of increasing the habits of mind score in the experimental class are significantly higher than in the traditional inquiry class in Table 6.

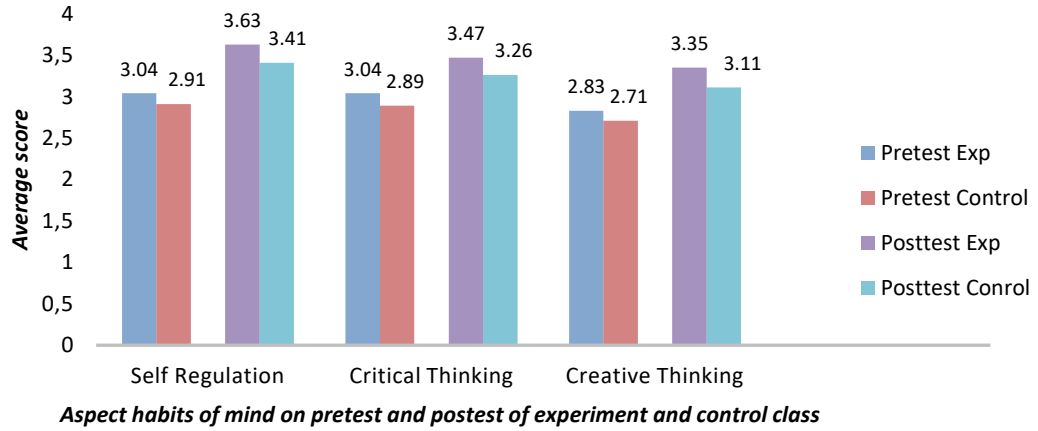

Figure 2. Score of result aspect of habits of mind of experimental and control class

Figure 2. shows the students' thinking habits scores. The figure shows that of the three aspects of habits of mind in classes with POGIL-BL, the highest score is in the self-regulation aspect (3.63), followed by critical thinking (3.47), and the lowest is creative thinking (3.35). In classes with conventional learning, the highest aspect is self-regulation (3.41), followed by critical thinking (3.26), and the lowest is creative thinking (3.11). Research finds that learning models influence students' thinking habits. It was also found that the POGIL learning model provided a higher contribution to thinking habits compared to conventional.

The POGIL stage, from the beginning, encourages students to be able to manage themselves. At the preparation and orientation stage, students prepare themselves to take part in learning by looking at materials (videos, images) on the Modle platform (e-learning) that provoke their curiosity to further make observations or analyses related to the material presented. In the exploration stage, students get tasks that must be done with their groups according to their respective roles. At this stage, they will be more serious and careful when looking for resources that are in accordance with the tasks given. Communication between group members began to be established, and questions and answers between members and lecturers were also established. at the concept formation stage, students are led to think critically, creatively, and analytically by being given questions that function to guide them to open relationships, and the right conclusions also help them construct their cognitive abilities. When the concept is identified, students are given exercises or assignments at the application stage to build confidence. Assignments using the environment around students on the topic of biodiversity encourage students to use the concepts they have obtained to conduct research and bring out critical and creative thinking skills. The activity ends at the reflection and evaluation stage, where students reflect on what they have learned and conduct assessments.

Research with POGIL learning shows that aspects of student self-regulation are higher than aspects of creative thinking and critical thinking. These results are in line with several studies that confirm self-regulation has the highest score (Sriyati & Haka, 2016; Hayat et al., 2019; Hidayati & Idris, 2020). According to Hidayati and Idris, (2020); Morosanova and Fomina, (2017) found that self-regulation as one aspect of habits of mind is easily achieved compared to other aspects because it relates to self-management ability that contributes to learning success. Students who are able to self-regulate will have metacognitive skills that will have an impact on self-regulation abilities and bring important contributions to learning outcomes (Listiana et al., 2016; Morosanova & Fomina, 2017). Meanwhile, in addition Mägi et al., (2016) states that self-regulation has a significant influence on controlling students' emotions, thoughts, and actions.

Next, are aspects of critical thinking and creative thinking. Both have lower scores than self-regulation. The critical and creative thinking skills of prospective teacher students develop quite well because students are given the opportunity to find and exchange information carefully and carefully through observation, experimentation, and making reports and conveying the results. When carrying out all these activities, students work earnestly and do not give up despite experiencing obstacles, trying to complete the tasks given with various strategies according to their abilities. Before carrying out activities, students will read related sources or references, reading activities have an effect on students' initial knowledge which can bring out interpretation and creative thinking and require them to think critically when receiving information Zubaidah, (2020) and critical thinking skills contribute to the development of the character of prospective teacher students (Hariyanto et al., 2022). The learning process carried out can improve students' thinking skills. Critical thinking is related to examination procedures (examining) and data analysis so that the decisions obtained depend on the results of the evaluation (Abrami et al., 2015), while creative thinking is the capacity of innovative thinking associated with the demands of innovative ideas cognitively (Kaufman & Beghetto, 2009). These two aspects of habits of mind are interrelated because critical thinking skills are needed to generate new concepts or answers (Wechsler et al., 2018).

The effect of POGIL-BL and conventional learning on students cognitive learning outcomes

The effect of POGIL and conventional learning on students' cognitive learning outcomes was obtained through the ANCOVA results with pretest scores as covariates. The effect of the learning model on students' cognitive learning outcomes is presented in Table 7. The table presents the differences in the learning model (F count= 127.743 with p value=0.000 while the value of $p < \alpha$ (α=0.05). Therefore, the proposed hypothesis was accepted. The learning model affects students' cognitive learning outcomes. Then, the LSD test was performed. The results are presented in Table 8.

Table 7. ANCOVA result (cognitive learning outcomes)

Source	*Type III sum of Squares*	*df*	*Mean Square*	*F*	*Sig*
Corrected Model	13094.875[a]	4	3273.719	91.810	.000
Intercept	1195.787	1	1195.787	33.535	.000
Pretest Cog	526.734	1	526.734	14.772	.000
Class	4554.994	1	4554.994	127.743	.000
Error	1961.167	55	35.658		
Total	272116.154	60			
Corrected Total	15056.042	59			

R Squared = .870 (Adjusted R Squared = .860)

Table 8. LSD test results (cognitive learning outcomes)

No	Class	Average		Average Corrected	LSD Notation
		pretest	posttest		
1.	POGIL-BL	46.74	80.20	77.57	a
2.	Conventional	38.74	52.55	54.85	b

Table 8 shows significant differences between conventional learning models and POGIL. It was reflected in the average posttest score. The POGIL scored the highest (80.20) and conventional learning (52.55). In detail, the average POGIL and conventional learning scores are presented in Figure 3.
Figure 3. shows the students' cognitive learning outcome scores with a maximum score of 100. The understanding aspect of both classes achieved the highest score compared to the other aspects, namely, the control class scored 61.74 while the experimental class was 84.89. The conventional class obtained the lowest score in the applying aspect, with a score of 48.38. Meanwhile, in the applying aspect, the experimental class obtained a score of 80.38.

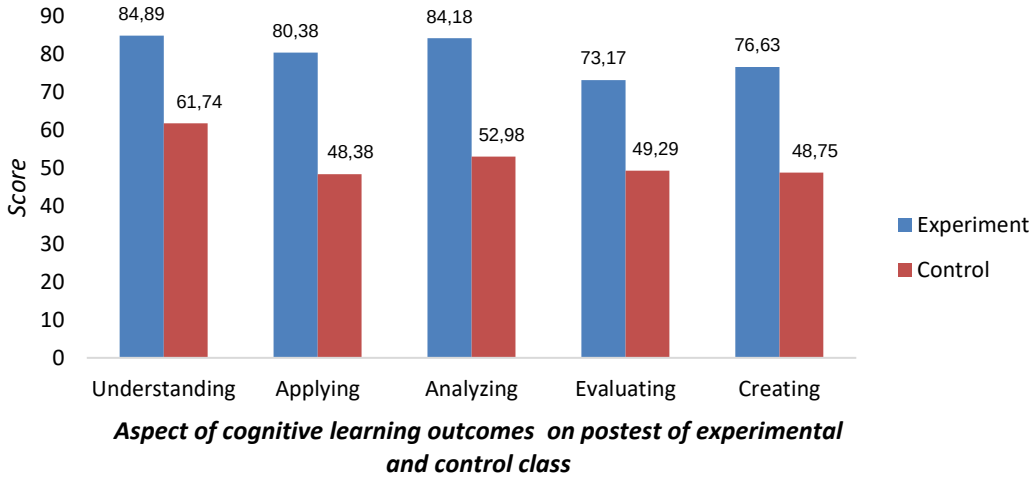

Figure 3. Score of result aspect of cognitive learning outcomes of experimental and control class

Research results showed that the learning model affected students' cognitive learning outcomes. However, it turned out that the POGIL-BL model provided the higher contribution to students' cognitive learning outcomes compared to conventional. POGIL-BL engages students in learning comprehensively through five phases with a focus on process and inquiry activities.
Initially, students were asked to read teaching materials or other sources according to the stimulus given through the Moodle (e-learning) platform. Reading can generate literacy and interpretation understanding, and also foster the process of cognitive expansion through the ability to think (Wang, 2012). Next, students carry out inquiry activities such as identifying problems, making assumptions, conducting investigations and collecting data/information, discussions to answer questions, finding main concepts and making conclusions. These results are in accordance with previous research which states that learning with guided inquiry has an influence on cognitive learning outcomes (Almuntasheri et al., 2016; Ural, 2016; Usmeldi, 2016). Inquiry activities give students the opportunity to build more complex knowledge and help strengthen the concepts they have acquired thus affecting cognitive learning

outcomes.

Conclusion

The study confirmed that POGIL-BL was applicable to promote students' habits of mind and cognitive learning outcomes. Habits of mind and cognitive learning outcomes are components students should master. To discover more about the POGIL-BL potential, further research could be carried out at different learning with different variables.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

E. Ariyati: methodology, analysis, writing original draft preparation, review and editing. **H. Susilo:** writing original draft preparation, review and editing. **H. Suwono:** writing original draft preparation, review and editing. **F. Rohman:** writing original draft preparation, review and editing.

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