

PROBLEM-BASED LEARNING USING E-MODULE: DOES IT EFFECT ON STUDENT'S HIGH ORDER THINKING AND LEARNING INTEREST IN STUDYING GEOGRAPHY?

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Abstract

Higher Order Thinking Skills (HOTS) are abilities that students in the 21st century must acquire. Problem-based learning (PBL) is one of the learning models to improve HOTS. In this study, PBL is integrated with technology through the use of e-modules. The taxonomy of Marzano is the framework used to assess HOTS. Student learning interest in studying geography as a moderate variable is a form of research refreshment that will result in a shift in research trends on PBL. Geography is the main focus of education in the 21st century, especially related to environmental issues. This study aimed to determine the effect of PBL with e-module based on HOTS to student's learning interest in studying geography. The research population consisted of second-year students (grade 11) of social class in SMAN 2 Semarang (Public Senior High School). The number of each student in the experimental class and control class is 32 participants. This research used a factorial experimental design. The data was collected using a test measuring HOTS and a questionnaire measuring enthusiasm for learning geography. The data were analysed using statistics, including the normality and homogeneity test, and hypothesis testing with the T-test, linear regression, and two-way ANOVA. The results found that: 1) PBL with e-modules had a significant effect on HOTS; 2) student's interest in studying geography had no significant effect on HOTS; 3) there was no effect between PBL and e-modules with student's interest in studying geography on HOTS. The HOTS test results were unaffected by the increase or decrease in student's interest. The HOTS is not influenced by student's interest in studying geography, but rather by the actual learning; 4) the highest indicator of developing HOTS is the capacity for abstract thought; 5) students conclude that using e-modules in PBL can improve interest for solving environmental issues. The combination of e-module content with project-based learning motivates students to protect the environment. Subsequent studies can focus on research on hybrid-based PBL as an innovation in 21st century learning.

Keywords – E-Module, HOTS, PBL, Student's interest.

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1. Introduction

National education objectives are determined by the quality of the learning process. Students' engagement and skill are essential for quality learning (Khairani, Suyanti & Saragi, 2020). Students should be allowed to interact with others, including classmates, family members, and members of society (Wu, Garza & Guzman, 2015). In practice, some teachers still keep to conventional methods of teaching and do not encourage their students to achieve their full potential (Misra, 2018). Initial observations indicate that learning problems in high schools in Semarang City appear to be teacher-centered, with a focus placed on content mastery. Students cannot obtain meaningful learning using only the lecture approach/conventional method in continuous learning (Maharjan, Dahal & Pant, 2022). The paradigm of education must shift from traditional to student-centered learning (Mingorance-Estrada, Granda-Vera, Rojas-Ruiz & Alemany-Arrebola, 2019). Students continue pursuing new knowledge, and teachers contribute as facilitators or mediators of learning, including geography learning. Students' knowledge must be contextualized so they can directly experience the conditions of surrounding environment.

Geography is one of the main topics of 21st-century education (Usher, 2021). Geography explores the connection between humans and their environment (Zhou & Liu, 2022). Teacher candidates who teach geographical values to their students must have fundamental field skills and value judgments (Adanah & Alm, 2019). Additionally, they are supposed to have a positive attitude and perspective on geography (Krischler, Powell & Cate, 2019). Previous study found that geography at SMA Negeri 2 Semarang is perceived as a less attractive topic due to the excessive usage of lecture and summary assignments. Geography is considered a monotonous and boring subject to study because learning is limited to theory (Dolan, Waldron, Pike & Greenwood, 2014; Kidman, 2018; Knecht, Spurná & Svobodová, 2020; Xeferis & Palaigeorgiou, 2019). Geography learning does not lead students to acquire new information by connecting contextual phenomena (Sari, Sumarmi, Astina, Utomo & Ridhwan, 2019). Geography learning must emphasize the problems and facts of the surrounding environment so that students are sensitive to the phenomena that occur in their environment (contextual) (Fatchan, Soekamto, Sumarmi & Utaya, 2016). Human activity can result in unexpected environmental issues. Geography learning is essential for solving spatial problems (Koç, 2018).

Students must learn to view and solve problems from a geographical viewpoint as part of their study of geography in the twenty-first century. (Silviariza, Sumarmi & Handoyo, 2021). PBL approach is based on the acquisition of knowledge and concepts through the solution of real-world situations (Saptenno, Evelyn, Tuaputty, Rumahlatu & Papilaya, 2019). PBL connects disciplinary knowledge to real-world situations; enthusiasm in problem-solving becomes a source of learning motivation (Smith, Maynard, Berry, Stephenson, Spiteri, Corrigan et al., 2022). Authentic learning involves a variety of concepts, including the idea that learning occurs in the context of authentic tasks – real-world situations that are closely related to the subject being studied (Roach, Tilley & Mitchell, 2018). Conventional learning models emphasize observable behavioral improvements, while the 2013 curriculum also requires changes in students' critical thinking skills (Munawaroh, 2020). The curriculum must develop students' interests and life skills in addition to facilitating learning, skills, and practices (Roh & Kim, 2015). PBL is founded on the concept of cognitive psychology, namely Piaget and Vygotsky's constructivism theory. According to constructivism theory, students acquire knowledge by interacting with their surroundings (Ültanır, 2012).

PBL encourages students to participate in learning activities that call for HOTS and gives them the opportunity to solve challenging real-world situations. (Prahani, Rizki, Nisa', Citra, Alhusni & Wibowo, 2022). According to Vygotsky, A constructivist theory known as sociocultural focuses on how the social environment influences learning (Schunk, 2012). In the same context, PBL activities in senior high schools at Semarang City, which focus on environmental issues in the city, raise attention to this issue. In these activities, students can directly experience environmental issues because they are Semarang locals. Students that receive local environmental learning are more likely to be able to think globally and act locally (Efendi, 2014). This implies that the objective of learning by raising local environmental issues is to develop global thinking skills, specifically by solving problems that exist in the surrounding environment.

Geographical problem studies applied both primary and secondary data as supporting evidence. Students should be given the opportunity to practice a variety of geographic skills to improve and expand their geographic knowledge to complete this research. Initial observations of geography teachers at SMAN 2 Semarang found that the assessment only concentrated on learning outcomes while ignoring the learning process and students' thinking skills. Students' potential can be observed in their thinking processes when learning, one of which is the ability to reason as a type of HOTS (Pappas, Pierrakos & Nagel, 2013). The focus of cognitive theory is on very complex thought processes (Ryan, 2012). HOTS are one of the factors that can influence student learning performance (York, Gibson & Rankin, 2015). The reasoning process is essential for the development of thinking skills (Surya, 2015). It is supported by Hunt's theory that HOTS involves explaining why something occurs or will occur in the future (Schunk, 2012).

Students' HOTS are typically lacking and underdeveloped. Several studies demonstrate that the poor HOTS scores of students are a reflection of traditional or teacher-centered learning. The teacher's perspective is directed on the validity of the final answer, so that students' thought processes are not considered and the expository method continues to dominate learning. HOTS indicators for the typical category of complex thinking, include comparing, classifying, making inductions, making deductions, examining errors, constructing support, abstracting, and assessing perspectives (Retnowati, 2019). PBL is characterized by characteristics of HOTS (Billah, Khasanah & Widoretno, 2019). PBL is able to develop students' HOTS and critical thinking skills (Sani, 2014). The 21st century learning paradigm emphasizes students' abilities to collect information from a variety of sources, analyze problems, think analytically, collaborate to solve challenges, and use information media and other technologies in their learning (Amin, Sumarmi, Bachri, Susilo & Bashith, 2020).

Several environmental problems are closely associated to the study of environmental conservation and sustainable development in geography. Students are asked to be sensitive to environmental issues (Suryawati & Osman, 2017). Students must come up with answers to these problems, requiring the reasoning ability as crucial skill (Beghetto & Kaufman, 2014). HOTS in students can improve learning outcomes or students' interest of geography learning (Jensen, McDaniel, Woodard & Kummer, 2014). Students' interests, in addition to their thinking skills, influence their performance in accomplishing learning objectives. PBL includes a variety of crucial factors that promote student engagement and motivation (Naji, Ebead, Al-Ali & Du, 2020). Students with high levels of critical thinking and student interest can acquire fundamental learning competencies (Kivunja, 2014). Student learning interest can be viewed as an individual's strength (energy) that can lead to a level of resilience and passion in performing an activity (Ediansyah, Kurniawan, Perdana & Salamah, 2019).

Initial study on PBL was conducted in several areas of medical science based on a literature review (Schmidt, 2012). The following trend in PBL extends to other scientific disciplines, including education (Savery, 2006). PBL is applied in the study of geography to determine its efficacy in promoting student learning outcomes (Caesar, Jawawi, Matzin, Shahrill, Jaidin & Mundia, 2016). In Indonesia, the Bloom taxonomy is used as an assessment of learning outcomes (Arlianty, Febriana, Diniaty & Fauzi'ah, 2018). In this study, PBL is integrated with technology through the use of e-modules. Contextually relevant problems are included in the e-module for students to solve based on field data. The taxonomy of Marzano is the framework used to assess HOTS (Insani, Pratiwi & Muhardjito, 2019). Student learning interest in studying geography as a moderate variable is a form of research refreshment that will result in a shift in research trends on PBL in Indonesia.

The teacher's model and the student's motivation to complete learning objectives both have an impact on the learning process (Al-Kumaim, Alhazmi, Mohammed, Gazem, Shabbir & Fazea, 2021). Students that are interested about learning have a lot of energy to focus to learning activities. Students' ability to achieve learning objectives and engage in learning processes vary, including their HOTS (Zajuli, Vivanti, Miarsyah, Ali, Pramita & Ageng, 2019). Therefore, teachers must innovate learning by selecting the appropriate learning model and focusing on student interests (Suryawati & Osman, 2017). PBL in geography disciplines is believed to promote HOTS in studying geography.

Syntax	Teacher's Activity
Stage 1: Lead students toward the problem.	The teacher discusses the instructional goals outlined in the e-module and encourages student participation in problem-solving activities.
Stage 2: Prepare students for the learning process.	The teacher assists students in identifying and organizing learning tasks related to the problem in reference with the e-module assignments.
Stage 3: Assist in individual and group research.	The teacher encourages students to acquire relevant data, conduct experiments, and find solutions.
Stage 4: Develop and display the work.	The teacher assists students in planning and developing relevant works such as reports, videos, and models, as well as in presenting their findings.
Stage 5: Analyze and evaluate the problem-solving process.	Teachers assist students in reflecting on their research and the strategies they use.

Table 1. Syntax of PBL model (Arends, 2013)

Currently, the teacher is changing to fit its role as a part of achieving academic objectives. Teachers have a responsibility to help students develop into individuals that support school's objective. The ability to select the appropriate learning model or method is one of the requirements of a teacher. If the teacher uses an effective learning model, it will be easier to accomplish the learning objectives, which will boost the student's learning mastery level, as well as their interest and foster a positive learning environment.

PBL is an alternative to traditional problem-based learning. PBL is based on the concept that problems can be used as a foundation for acquiring or integrating new information. In a PBL environment, students typically work cooperatively in groups of four to six individuals to solve real-world problems by sharing newly acquired information (Golightly, 2021). The five levels of PBL are shown in the following Table 1.

Syntax must guide the interaction between teachers and students in PBL. The teacher manages problem situations to direct students in developing problems, assisting in formulating and testing hypotheses, and confirming the validity of problem solutions (Bellová, Melicherčíková & Tomčík, 2018). Teachers must develop learning materials, including both media and information sources. Teachers must develop learning materials, including both media and information sources.

The purpose of the e-module in PBL is to investigate the impact of students' interest in studying geography on their ability to use HOTS. The research problem is identified as follows:

1. How does PBL with e-modules affect the HOTS of high school students?
2. How does student's interest in studying geography affect the HOTS of high school students?
3. How does the relationship of PBL, e-modules, and student interest in studying geography affect the HOTS of high school students?
4. How does the development of HOTS of high school students?
5. How do students respond to the use of PBL with e-modules?

2. Methodology

This research is a quasi-experimental research that is controlled under existing conditions (Strang, 2015). The participants in this study were separated into two groups: an experimental group and a control group. The data collected is the result of data on HOTS and learning interest in studying geography. The population of this study were second-year students (grade XI or grade 11) of SMA N 2 Semarang, selected using purposive sampling technique. The sample were students from social class 1 (XI IPS 1) as the control group and social class 2 (XI IPS 2) as the experimental group. The number of each student in the experimental class and control class is 32 participants. The sample was selected based on the mid semester achievement that reflects students' cognitive capabilities. This study design used a 2×3 factorial layout. The design of experimental study is shown in the following Table 2:

C	B	A	
		A1	A2
C1	B1	X	O
	B2		
	B3		
C2	B1	O	X
	B2		
	B3		

Table 2. Research design

Description:

- C : Groups
- C1 : Experimental Group
- C2 : Control Group
- A : Learning Model
- A1 : PBL
- A2 : Discussion
- B : Student’s learning interest Level
- B1 : High Level of Interest
- B2 : Middle Level of interest
- B3 : Low Level of Interest
- X : Receive Treatment
- O : Not Receive Treatment

The teaching materials used in the experimental groups is differed from the control group. The experimental class used e-modul to solve environmental problems in a brief report containing problems, affects, implications, and problem-solving solutions. In the control class, learning is documented in a portfolio that corresponds to the course material. Students’ HOTS were assessed using framework from Marzano (Suryani, Sapriya, Malihah, & Komalasari, 2020), and student’s interest in studying geography was measured using a questionnaire based on indicators from (Daldjoeni, 2014; Sardiman, 2014). This study applied a multiple-choice questionnaire. Students were given pretest and posttests receiving PBL with e-modules in the experimental class and conventional learning in the control class. Utilizing n-gain, it is possible to identify the improvement of HOTS in the teaching and learning process using PBL with e-module by paying attention to students’ interest in studying geography using N-gain. The formula to analyze N-gain is shown as follows:

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

(Meltzer, 2002)

The analysis results are interpreted using the gain index is shown in Table 3.

N-Gain	Interpretation
N-Gain > 0,70	High
0,30 ≤ N-Gain ≤ 0,70	Moderate
N-Gain < 0,30	Low

Table 3. Normalized n-gain classification (Kusnendi, 2013)

The following hypotheses are tested in this study:

1. There is an effect of PBL with e-module on high-level thinking skills of high school students.

2. There is a correlation between high school pupils' high-level thinking skills and their enthusiasm in learning geography.
3. There is PBL interaction with e-modules with high school students' enthusiasm in learning geography on high-level thinking skills.

This research uses the normality test, the homogeneity test, and the t test, linear regression, and the Analysis of Variance (ANOVA) test for hypothesis testing. Testing the normality assumption is required before testing the comparative hypothesis with parametric statistics; if the test results are not normally distributed, nonparametric testing is performed. The two-average difference test was used to measure the average difference between students in the experimental class with PBL treatment with e-modules and the control class with conventional learning. The t-test, which uses parametric statistical methods to test the comparison hypothesis of two independent samples, is the bivariate comparative analysis that is performed when the data are normally distributed and homogeneous. The Polled Variance Formula is utilized for the t-test when the two averages of the two samples have different numbers with homogeneous data variance (Sugiyono, 2014).

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Description:

- \bar{x}_1 : the average of sample 1
- \bar{x}_2 : the average of sample 2
- S_1^2 : the variant of sample 1
- S_2^2 : the variant of sample 2

The second hypothesis was evaluated using simple linear regression analysis. The purpose of this analysis was to evaluate the relationship between student's learning interest in studying geography and HOTS. This study applied the Analysis of Variance (ANOVA) formula to evaluate the moderating variable hypothesis. This study focused on two variables, namely the increase in HOTS and the student's learning interest in studying geography, and used a two-way ANOVA to analyze variables.

Data	Kolmogorov-Smirnov (Z)		H ₀	Levene		H ₀	Result				
	Statistik	Sig.		Statistik	Sig.		Normality	Homogeneity	Hypothesis 1	Hypothesis 2	Hypothesis 3
N-Gain: Experimental Group Control Group	0,77 1,47	0,58 0,02	Accept Reject	1,42 0,23	Accept Reject	Normal	Homogeneous	Parametric: Independent-Sampel t test	Simple Linear Regression	Analysis of Variance Two Way	

Table 4. Results of normality and homogeneity of high order thinking skills

Table 4 shows that the results of the normality test and homogeneity test required to use parametric statistical analysis with the Independent sample t-test to answer the research questions.

3. Result

3.1. The Effect of PBL with E-Modules on Students' High Order Thinking Skills

The first hypothesis is tested to examine the impact of PBL on students' HOTS. This test was carried out by comparing HOTS scores between the experimental class that used PBL with e-modules and the control class with conventional learning. The comparison of pretest and posttest of the experimental and control group for HOTS is shown in the following Figure 1.

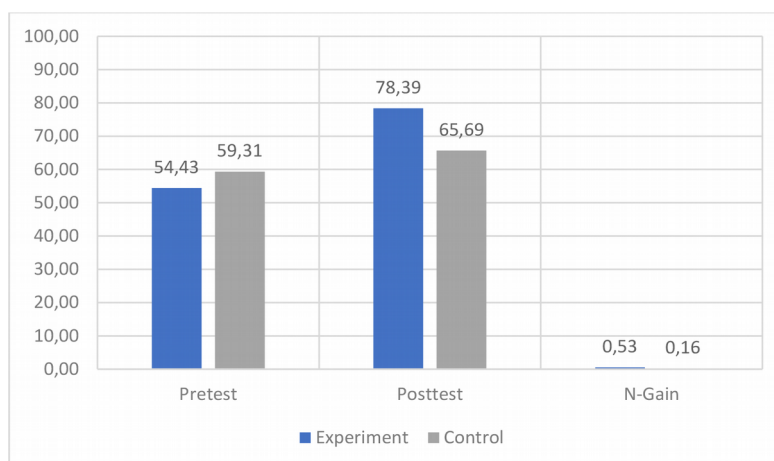


Figure 1. Pretest and posttest scores of students' high order thinking

The average normalized gain achieved by students in the two classes varied. The results of hypothesis testing 1 are shown in the following Table 5.

Data Category	t	df	Sig.
N-Gain Experiment and Control Groups	8.236	64	0.000

Table 5. Results of independent-sample t-test

The results of testing hypothesis 1 in the Independent-Sample t-test table showed that sig. value is 0.000. The significance threshold = 0.05 indicated that the sig. value is decreasing. This indicated that the results of testing hypothesis 1 are accepted, whereas hypothesis 0 is rejected. It can be concluded that there are differences between group that use PBL with e-modules and conventional learning in the HOTS of geography students. The development of a substantial relationship between PBL and HOTS demonstrated that contextual learning has an effect on students' HOTS that differs from text-based learning.

3.2. The Effect of Interest in the Study of Geography on Students' Higher Order Thinking Skills

The second hypothesis is tested to examine the relationship between students' learning interest in studying geography and HOTS. This test is conducted by examining the n-gain of higher order thinking scores on students' learning interest in the study of geography. Testing is performed using a simple linear regression analysis. The findings of the hypothesis testing 2 are shown in the following Table 6.

At the output, the calculated F value is 0.957 with a significance level of 0.336 or greater than 0.05. Thus, student's HOTS were not significantly affected by the learning interest. This indicated that H1 is rejected and H0 is accepted as a result of testing hypotheses 2. The test results showed that learning interest has low effect on HOTS and suggested that other factors may influence student's HOTS.

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	63.812	1	63.812	.957	.336 ^b
	Residual	1999.667	30	66.656		
	Total	2063.479	31			

Table 6. The results of simple linear regression test

3.3. Interaction between Problem Based Learning with E-modules and Learning Interest in Studying Geography on High Order Thinking Skills

The third statistical test is designed to determine whether PBL, e-modules, and learning interest in studying geography connect to affect students' HOTS. Testing the interaction between PBL using e-modules and learning interest in studying geography is used a two-way analysis of variance (ANOVA). The results of hypothesis testing 3 are shown in the following Table 7.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.089a	3	0.696	22.216	0.000
Intercept	5.558	1	5.558	177.315	0.000
Interest	0.012	1	0.012	0.382	0.539
Class	1.593	1	1.593	50.827	0.000
Interest * Class	0.001	1	0.001	0.030	0.864
Error	1.943	62	0.031		
Total	11.359	66			
Corrected Total	4.032	65			

Table 7. Results of the analysis of variance

According to Table 7, the sig. value of learning interest in studying geography has no effect on the n-gain of HOTS. The sig. value between students' learning interest in studying geography and learning is 0.864. This indicated that H₀ cannot be rejected as the obtained sig value is bigger than 0.05. The result of the plot graph is shown in the following Figure 2.

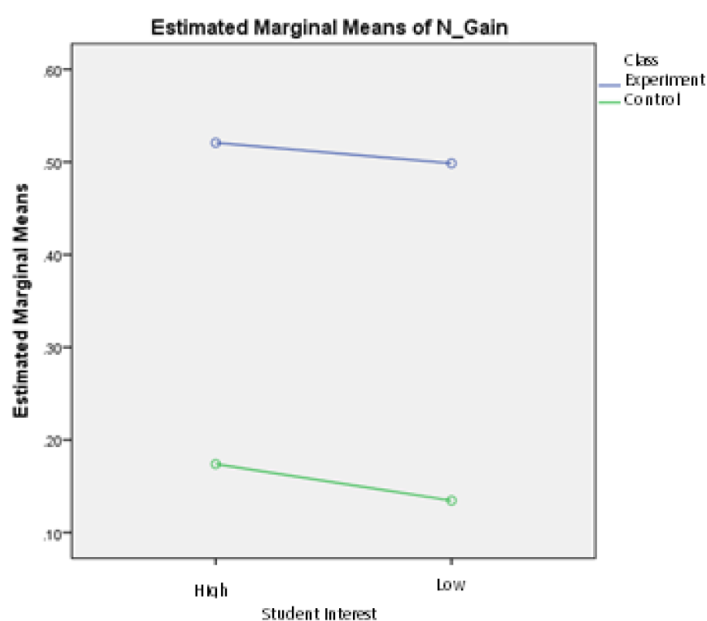


Figure 2. Correlation of learning interest in studying geography and project-based learning with e-modules on HOTS

The plot graph showed that the experimental class had a higher average number of students with high and moderate levels of HOTS than the control group. The effect of the four treatments (high interest in experimental group, moderate interest in experimental group, high interest in control group, and moderate interest in control group) on improving students' HOTS was not statistically different. Students' HOTS are not immediately affected by the learning interest in studying geography, but rather by PBL using e-modules.

3.4. Differences in Students' High Order Thinking Skills Per Indicator

The improvement of HOTS per indicator is shown in the following Figure 3.

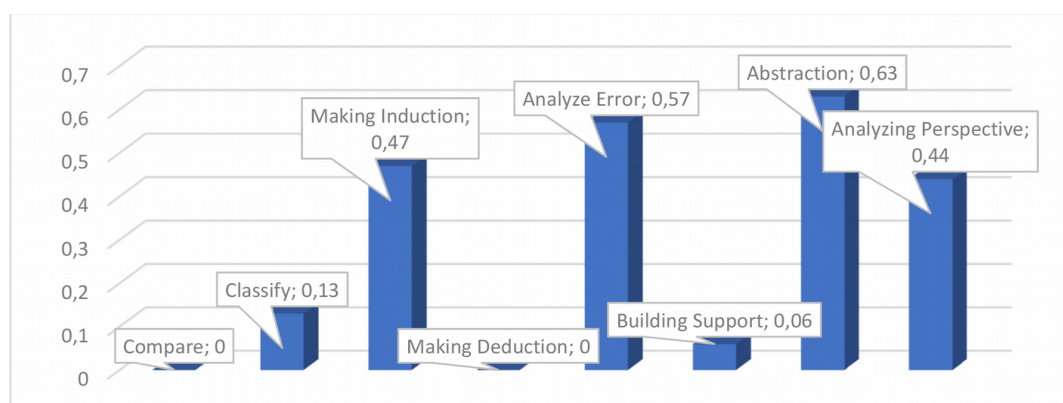


Figure 3. Average n-gain per indicator of HOTS

The average n-gain on each indicator of high-level thinking skills for the experimental group ranges between the moderate and low categories, as shown in Figure 3. The indicator of abstraction has the highest average n-gain, which is 0.63, while the indicator of comparing and making deductions is 0.00 or no improvement from the pretest to the posttest. The proportion of n-gain for each indicator is dominated not only by the high and low categories, but also by the indicators of examining the perspective of students with moderate n-gain that reaches 50%. While the indicator of comparing and making deductions, the gain value is in the low group, indicating that there is no improvement between the pretest and posttest scores.

3.5. Student Responses to Problem-Based Learning with E-Modules to Improve Learning Interest in Studying Geography

The fifth statistical test is intended to evaluate how students respond to previous acquired knowledge. The student responses to PBL with e-modules in students' learning interest in studying geography is shown in the following Figure 4.

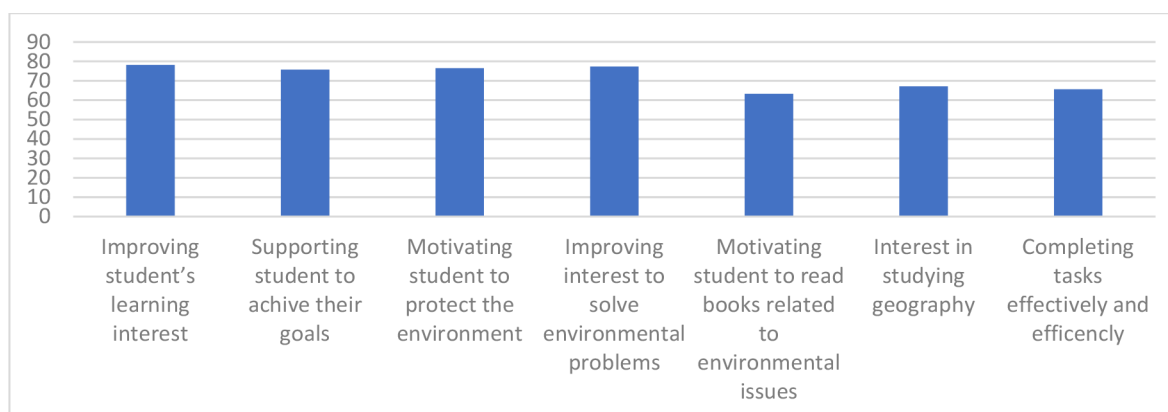


Figure 4. Student responses to project-based learning with e-modules based on student interests

Figure 4 showed that PBL using e-modules can enhance students' learning. Students demonstrated a high level of interest in completing student assignments due to their motivation to excel by achieving positive learning outcomes. Students' learning interest in environmental conservation is quite strong in studying geography, with a total of 76.56%. However, only 63.28% of student responses believed that PBL would increase students' learning interest in reading.

4. Discussion

This research used PBL using e-modules as a learning model for geography class in order to determine its impact on students' HOTS and evaluated by the learning interest in studying geography. PBL is a scientific method of teaching that is widely used across many subjects, including Geography (Silviariza et al., 2021). The PBL model is based on real-world issues (Cörvers, Wiek, de Kraker, Lang & Martens, 2016). The problems identified in this study are difficulties that students in Semarang experience when trying to achieve learning objectives. Contrary from the constructivism theory, which maintains that learning is a process in which students of any age are actively engaged in the process of acquiring information and constructing their own knowledge with other students, this study proposes that learning is a process in which students are actively involved in the process of acquiring information and constructing their own knowledge simultaneously (Schrader, 2015). Constructivism, including cognitive and social constructivism, involves a shift of responsibility for learning from the teacher to the student (Golightly & Raath, 2015).

Technology can assist students in solving learning challenges. Teachers must adapt to the usage of technology in the classroom. Electronic resources must be used by students and teachers (Gudmundsdottir & Hatlevik, 2018). Technological pedagogical and content knowledge (TPACK) is one of the skills that teachers must acquire. TPACK carried by educators can facilitate the delivery of relevant learning (Adipat, 2021). E-module is a form of integrating technology into the learning process (Istuningsih, Baedhowi & Sangka, 2018). The E-modules used in PBL feature challenges that students must solve.

4.1. The Effect of PBL with E-Modules on Students' High Order Thinking Skills

Based on the analysis of the n-gain from experimental group and the control group, it is known that the improvement of students' HOTS differs between groups using PBL with e-modules and groups using conventional learning. After receiving the e-module, students in the PBL group with the e-module had higher HOTS than students in the control group. The experiences that students bring to learning environments can have an effect on treatment learning outcomes (Sumarmi, Aliman & Mutia, 2021). Authentic context in the classroom is more than representations of the concepts being taught using simple examples from real-world experience (Roach et al., 2018). Experiential learning is described as the process when knowledge is created through the transformation of experience (Smeds, Jeronen & Kurppa, 2015). Authentic learning is used here in its wider definition, referring to situations in which learning is encouraged by being in an environment that integrates learning objectives with tasks, content, and real-world contexts (Roach et al., 2018). Authentic PBL encourages students to investigate a variety of facts, events, and environmental issues (Amin, Utaya, Bachri & Sumarmi, 2020).

The implementation of learning in the experimental group puts the teacher to fit with their role, namely as a facilitator. Teachers in problem-based education are experts who handle problem situations, direct students to construct problems, assist in formulating and testing hypotheses, and verify the validity of solutions (Tsankov, 2012). HOTS differ between successful and unsuccessful students (Cox, Elen & Steegen, 2019). PBL can develop and enhance students' HOTS and critical thinking skills (Prahani et al., 2022). Students can better understand the value and relevance of the learning through authentic learning (Iucu & Marin, 2014). Authentic activities or tasks reflect the types of actions that individuals conduct in the actual world and are completed over a continuous period of time, as compared to a series of shorter examples (Hidayati, Benti & Eldarni, 2022).

PBL is a strategy for lifelong education in which students engage in small groups to discover challenges at the center of learning situations that represent actual issues (Adanali & Alim, 2017). Geography education

is closely related to students' everyday lives. In addition, geography education must emphasize the significance of problem solving so that students can develop HOTS (Sumarmi, 2012). PBL encourages students to solve problems by searching for information based on the reality of the topic and implementing it (Sari, Sumarmi, Astina, Utomo & Ridhwan, 2021). Authentic activities have real-world relevance and are as similar as possible to actual professional responsibilities (Roach et al., 2018).

PBL gives students with opportunity to collaborate in solving real-world problems. Applying PBL model is supported by the accuracy of the 21st-century learning approach (Amin, Sumarmi et al., 2020). PBL is an instructional model that emphasizes collaborative problem-solving activities (Garmendia, Aginako, Garikano & Solaberrieta, 2021). PBL integrates two learning theory pillars, namely social constructivism and cognitive constructivism (Hidayati, Zubaidah, Suarsini & Praherdhiono, 2019). The role of environmental problems in project-based learning can enhance HOTS (Magsino, 2014). Students must be directed to be more active and creative in problem-solving, both in their studies and in their future activities, and this must be accomplished through innovative and creative learning (Susbiyanto, Kurniawan, Perdana & Riantoni, 2019). Furthermore, the contribution of e-modules to learning is substantial. Internet information is the primary source of data used for problem solving (Prahani et al., 2022). E-modules offer another encouragement for students to engage in learning (Fahmi, Yusuf & Muchtarom, 2021).

4.2. The Effect of Learning Interest in Studying Geography on Students' High Order Thinking Skills

Based on the results of linear regression analysis, it was concluded that learning interest had no significant effect on students' HOTS. This conclusion contrasts earlier findings that learning interest affects students' high order thinking skills. This research demonstrates that HOTS skills are influenced by more dominant factors, including the use of technology in learning materials (Wijnen, Walma van der Molen & Voogt, 2021), learning strategies and approaches (Minarni & Elvis-Napitupulu, 2019). Although this research indicates that learning interest does not significantly impact thinking skills, learning interest is a crucial aspect in the learning process and outcomes (Ricardo & Meilani, 2017). Multiple research concluded that learning interest correlates more significantly with learning motivation (Heriyati, 2017). Further, student's learning interests, teacher attitudes and teaching materials, family encouragement, colleagues support, the environment, including mass media that are frequently read by students, and the surroundings also influence student's interest in learning. Students' learning interest is affected by their aspirations. Similar to the conditions of family support, environment, and friends that provide these students with an externally positive learning environment. Currently, the mass media has a significant impact on students' laziness in the classroom and, on sometimes, their sexual behavior. It is believed that these elements contributed equally to the increased learning interest and critical thinking skills of students.

4.3. Interaction between Problem Based Learning with E-modules and Learning Interest in Studying Geography on High Order Thinking Skills

The results of the two-way ANOVA indicated that there is no interaction between learning and students' learning interest to improve the HOTS. The significance value of learning interest is 0.831. (greater than 0.05). This indicated that there is no interaction effected between the treatment of the learning model and students' learning interest, since the learning model is not depending on students' learning interest in studying geography. Teachers must develop their own understandings of what produces significance for their students in the classroom (Teo, 2019). Authentic learning involves increasing motivation and interest, empowering students to make decisions about their own learning, and exploring non-traditional learning methods to enhance performance (Hite, Solís, Wargo & Larsen, 2018). The learning experience is both authentic to the learner and authentic to the community of practice (Roach et al., 2018).

Several findings from previous research indicated that the learning model or approach had no effect on students' interest to enhance their learning outcomes (Chen, Yang & Hsiao, 2016; Mulyanto, Gunarhadi, & Indriayu, 2018; Permatasari, Gunarhadi & Riyadi, 2019). The usage of learning methods and students' interests to increase conceptual understanding demonstrated that there is no interaction impact between

learning methods and students' interests and concept mastery (Rabgay, 2018). In the experimental class, individuals with high and moderate interest in higher order thinking were still better to those with high and moderate interest in the control group. Students' HOTS are influenced by the applied learning model rather than their interests. This indicates that there is no relationship between learning methods and students' learning interest to comprehend the topic, despite the possibility of several factors influencing it. PBL is learning can develop thinking skills because students in a problem-based approach will review problems to better their thinking processes. The findings confirm that PBL is learning that can improve thinking skills (Hussin, Harun & Shukor, 2018).

4.4. Differences in Students' High Order Thinking Skills Per Indicator

According to the results of the analysis of HOTS, the average n-gain for each indicator of HOTS ranges between the medium and low categories. The average n-gain is highest for the indicator of abstraction. The ability of abstraction can be observed through the process of symbolizing everyday difficulties. This indicates that PBL with e-modules involves context-rich scaffolding from contextual problems. Rich context implies that teachers can direct students to identify multiple solutions (rich solutions) to the contextual challenges offered. PBL can enhance abstract reasoning, generalization, and formulation of everyday problems. The students' empirical experience influences the learning process. Students are able to comprehend a subject when the challenges presented correspond to their everyday experiences (Yusepa, 2017). Further, students can construct concepts based on previously mastered theories. The lowest n-gain value is on the indicator of compares and makes deductions. Lack of comprehension and application of good reasoning in solving provided questions is a common cause of insufficient subject mastery among students (Indah & Nuraeni, 2021). This is also in line with the results of this study, which indicate that students' deductive thinking ability is low.

Figure 3 further demonstrated that the value of the indicator of comparison is extremely low. This is also in line with studies indicating that evaluation thinking skills, such as the indicator of comparison, are not as easily acquired as other thinking abilities such as inference, analysis, and interpretation (Aliman, Roekhan, Harsiati & Marni, 2020). Similarly, the indicators of examine error and analyze perspective that students hold are also categorized as moderate, but are higher than the indicators of creating inductions, categorizing, and comparing. Because students need these skills to evaluate facts, identify arguments, and analyze arguments from observed difficulties, the ability to assess errors and perspectives should be improved.

4.5. Student Responses to Problem-Based Learning with E-Modules on Increasing Learning Interest in Studying Geography

According to the analysis of student responses to PBL with e-modules, it is believed that the use of e-modules in PBL can increase students' interest in both learning and solving environmental problems. The combination of e-module content and challenges to be solved during learning motivated students to protect the environment (Amin, Utaya et al., 2020). The number of responses was lowest for PBL using e-modules that could encourage students to read books on environmental issues. Students may not yet be familiar to using e-modules, which may contribute for the low response indicator of motivation to read books on environmental issues. It is easier for students to use the module in print format. Meanwhile, the utilization of e-modules can boost students' motivation, creativity, and learning independence. Good instructional resources are those that accommodate the conditions and characteristics of students. Teaching resources should be able to affect student behavior; also, teaching materials should be able to assess student performance in understanding the topic (Fahmi et al., 2021; Istuningsih et al., 2018).

5. Conclusion

1. Based on the results of analysis and hypothesis testing, as well as the results of researchers' observations, it can be concluded that PBL models have an effect on students' HOTS. PBL, which requires students to conduct authentic investigations to identify solutions to problems,

influenced the development of students' HOTS. Students' HOTS improved when learning is focused toward effective problem solving. There is a difference between the experimental group and the control group in terms of their HOTS, with the experimental group showing better results. Therefore, the PBL approach is more effective than the textual discussion method at improving students' HOTS.

2. This finding contradicts previous studies which suggested that students' HOTS are influenced by the learning interest. This suggests the possibility that other variables have a stronger impact on HOTS. Although this study's findings indicated that learning interest did not significantly influence thinking skills, learning interest played a crucial role in the learning process and outcomes.
3. This study found no significant interaction between the learning model and students' learning interest in HOTS. Due to the lack of meaningful interaction, the efficiency of learning in the classroom does not depend directly on the students' interests. Consciousness is a component of social psychology that adopts the cognitive domain, from a scientific perspective.
4. The highest indicator in improving HOTS is abstraction ability. These results demonstrated that students can identify multiple solutions (rich solutions) to the context-based challenges offered. During the process of PBL, the indicator of compare and draw conclusions about areas is not improved.
5. Students believe that using e-modules in PBL can increase students' interest in both learning and solving environmental problems. The content of the e-module is mixed with questions to be answered in order to motivate students to protect the environment. Student's environmental awareness is influenced by their personality and value system. Environmental awareness is required to solve environmental problems. Environmental awareness develops when it is followed by attitudes and actions that protect the environment, whereas environmental management requires knowledge.

Declaration of Conflicting Interests

The authors declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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