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THE EFFECT OF APPLYING THE ETHNO-STEM-PROJECT-BASED LEARNING MODEL ON STUDENTS' HIGHER-ORDER THINKING SKILL AND MISCONCEPTION OF PHYSICS TOPICS RELATED TO LAKE TEMPE, INDONESIA

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ABSTRACT

This study aims to determine the effect of applying the Ethno-STEM-Project Based Learning model about the concept of physics related to Lake Tempe on students' conceptual understanding of physics, which is characterized by higher-order thinking skills and the level of misconceptions. The sample in this study was eleventh-grade students in senior high school. Students are exposed to local wisdom-based learning strategies integrating science, technology, engineering, and mathematics through group project assignments. Students are given a pre-Achievement Test (PAT) to determine their initial Higher-Order Thinking Skill of physics concepts in everyday life. Then after being treated through project work, they are asked to do a Post-Achievement Test (PAT). A three-tier test was carried out before and after treatment to determine the level of misconceptions. In addition, focus group interviews were conducted with several students to strengthen the pre and post-test results. Student responses to focus group interviews and the PAT's open-ended questions were analyzed using the N-Gain Score equation. The data in the initial and final tests were analyzed quantitatively and qualitatively. Based on the analysis results, it was found that using the Ethno-STEM-PjBL model affected the understanding of physics concepts. It was marked by increases in higher-order thinking skills and decreases in misconceptions on several physics topics related to students' activities around Lake Tempe.

Keywords: etnho-STEM project-based learning; Lake Tempe; local culture understanding in Physics

INTRODUCTION

The secondary education curriculum that applies in Indonesia encourages science learning to be more contextual, emphasizing knowledge and experience in the real world. It means that every concept taught can be related to the social, economic, and cultural activities experienced by students every day. It is intended to make learning more interesting, not to make students fantasize about the various theories from class, and to encourage students to be more active, creative, and able to solve problems. Several science education researchers have suggested aligning students' daily and school experiences with everyday sociocultural realities (Mpofu et al., 2014; Abah et al., 2015). To help students understand science as a human endeavor rather than an obscure subject found only in the environment, some of these researchers have suggested integrating real knowledge from students' everyday experiences with the science curriculum in schools. This will make the curriculum culturally relevant and local wisdom. To make it simpler for students to comprehend science learning in the classroom completely, they have proposed a science curricu-

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lum that incorporates students' actual knowledge they acquire from daily life with science learning at school (Khupe, 2014; Fakudze, 2021).

Students' daily lives can be integrated into science learning, such as physics. Physics is closely related to everyday people's phenomena and activities (Duit, 2014). One example is the life and activities of the people around Lake Tempe. Based on the initial study, the following information was obtained. Four schools were located directly adjacent to Lake Tempe, with most parents and students carrying out their daily activities on Lake Tempe, such as fishing, living in floating houses, and using boats to and from home. If analyzed in depth, all these activities are closely related to various physics concepts, such as fluid.

Most students have a misconception about physics and use this concept a lot in everyday life. However, previous studies on understanding the fluid concept of several students around the lake showed that most did not understand the physics concept well. Some of them experience misconceptions, especially about fluid. They cannot explain correctly how an object can float. When students were asked, "which floating house is safe, a house with a lot of buoys or a few?" most answered the house with many buoys, which is correct. However, when asked for reasons, their answers were wrong.

The inability of students to integrate their knowledge and experiences in their respective environments concerning physics concepts is because most physics learning in these schools is theoretical. They are never directed to think critically and creatively about the various phenomena and events they experience. In other words, their learning ability is not well-developed (Sumarni, 2015). In addition, the teacher dominates learning. The learning process is carried out in the classroom, emphasizing memorizing concepts and formulas rather than stimulating students' curiosity in learning in the laboratory or the surrounding environment. The idea of "final" is commonly accepted by students, and they are urged to believe all their teachers say (Sudarmin et al., 2019). In addition, students are rarely encouraged to prove the various physics concepts they get in class. They take for granted the information provided by the teacher. Higher-order thinking skills are not typically required for most of the assignments and test questions. They are not guided through analyzing, evaluating, or creating physics concepts in every evaluation question. Students are rarely asked to evaluate why a phenomenon can occur, how the relationship between physical variables and concrete examples appear in everyday life, and the relationship between one concept, theory, and law with other concepts. Learning and teaching physics rarely give students the chance to express their thoughts or come up with original solutions to problems.

In addition, based on preliminary studies, conceptual understanding measured by teachers so far has been more on issues that require low-level thinking skills. For example, "if a boat is traveling at 5m/s, how long will it take to cover a distance of 150 m?" Questions like this do not require in-depth analysis and only train students to memorize formulas. Even though students can answer these questions, it does not mean they have understood the physics concept well. For example, "if given a larger boat load with a modified front, what is the speed of the boat? How is the wind related to boat speed?". Students with excellent reasoning and analysis can answer every physics problem correctly. Problems related to everyday physics were also asked, such as "how to lift fishing nets easily?". Students cannot provide solutions to these problems. The low ability to reason, analyze, solve problems, and think critically and creatively shows that students' high-order thinking skills are still low.

Increasing understanding of physics concepts and reducing misconceptions require higher-order thinking skills. Students must get used to analyzing, evaluating, and creating every given daily problem. Evaluating is a person's ability to judge conditions, values, and ideas. Analyzing is the ability to break a unit into several parts and determine how these parts relate to each other or partially to the whole (Ramadhan et al., 2020). Another definition from Anderson and Krathwohl is that evaluation is the ability to judge based on specific criteria and standards. Quality, effectiveness, efficiency, and consistency are often used, while standards determine quality and quantity (Anderson & Krathwohl, 2001). Creativity is one's ability to combine and develop various information into something new (Tari & Rosana, 2019). Anderson and Krathwohl (2001) revealed that creating is assembling elements into a coherent and functional totality.

Nowadays, higher-order thinking skills are an obligation that students must possess. Higher-order thinking skills can support each student's ability to be a solution for each other and the surrounding environment (Brierton et al., 2016). This skill also impacts students' sensitivity to the social environment and motivates them to become problem solvers. Higher-order thinking-based learning is thought to enhance students' capacity to mentally prepare for complex and developing eras and to live a more sociable lifestyle (Chetty, 2015). Therefore, learning that involves higher-order thinking skills is necessary to grow.

To improve higher-order thinking skills, especially in physics learning, it is necessary to apply appropriate learning models and measurement tools (Ramadhan et al., 2019). The following steps can be taken to develop students' thinking skills: 1) utilizing active learning techniques to engage students in the learning process as opposed to depending solely on lectures and memorization; 2) emphasizing the learning experience rather than the material; and 3) employing evaluation methods that put students through intellectual tasks as opposed to memory tests (Nourdad et al., 2018). This skill will develop properly if the teacher deliberately encourages students' thinking potential, manages a learning in a planned manner (Sudarmin et al., 2020; Sumarni & Kadarwati, 2020), and creates exciting and memorable learning so that it will be more readily accepted and stored for a long time in students' memories (Palloan & Swandi 2019; Swandi et al., 2020). Through engaging in learning activities, students can expand their problem-solving skills and apply those learnings to their everyday experiences. Critical, logical, reflective, metacognitive, and creative thinking are instances of higher-order thinking skills (Wang & Wang, 2014; Widana et al., 2018). To be successful in developing HOTS, there must be a specific goal in the school curriculum for teaching and educating students in critical and creative thinking.

Students are encouraged to analyze various physics concepts and relate them to everyday activities to build higher-order thinking skills in physics learning. Thus, a learning approach that incorporates students' environmental activities into science learning is required. Project-based learning is a practice-based innovation that has been utilized for a while by many educators to create learning processes based on everyday obstacles or problems that motivate students to research, make choices, design, and complete a product (Uziak, 2016). Based on previous studies, implementing project-based learning will enable 21st-century educators to create better practices for teaching by integrating science, technology, engineering, and mathematics (STEM) (Afriana et al., 2016). Teachers can use STEM to show students how ideas, rules, and laws from science, technology, engineering, and math are incorporated into the creation of everyday systems, processes, and products. It is supported by the demands of the times. Everyone must be accustomed to dealing with problems with a technological approach, appropriate techniques, and the help of mathematics.

In addition, attention to local wisdom (ethno) that has developed since ancient times is urgently needed. Integrating local wisdom with physics concepts will strengthen students' conceptual understanding they get outside and inside the classroom. It aligns with previous research that learning science that optimizes local wisdom in the student's environment and connects to good learning will be more appropriate (Subali et al., 2015; Novitasari et al., 2017). When the teacher explains the principle of floating (Archimedes' law), the teacher directs students to analyze why the house they live in in the middle of Lake Tempe can float if given treatment in these circumstances, for example, by adding more weight to the top of the house or changing the position of the drum. Therefore, integrating science, technology, engineering, and mathematics in explaining the physics concept around the students' environment can solve the misconceptions.

STEM education is currently a well-known strategy among educators due to the growing global technological perspective of the 21st century (Shernoff et al., 2017). STEM is currently used in western countries and Asian countries, especially Indonesia. STEM is a related scientific field that uses technology and engineering as science applications as well as mathematics as a tool for data processing (Afriana et al., 2016). Students are supposed to become more creative problem solvers, independent workers, logical thinkers, and technologically proficient through STEM education (Afriana et al., 2016).

Due to the high level of misconceptions experienced by students around Lake Tempe and their high-level thinking skills about physics phenomena that they experience every day are still very low, this research is conducted. Therefore, integrating STEM-local wisdom with a project-based learning model (ethno-STEM PjBL) will solve problems in science learning (Sudarmin et al., 2019; Sumarni & Kadarwati, 2020). Through this model, students must carry out projects collaboratively to test concepts, theories, and physical phenomena in everyday life (Risdianto et al., 2020; Azis & Yulkifli, 2021). This model is expected to explore local culture to develop critical, creative, innovative, and collaborative thinking skills and develop students' character (Novitasari et al., 2017; Sudarmin et al., 2019, 2020; Reffiane et al., 2021).

Various ethno-STEM PjBL studies significantly influenced student entrepreneurship (Sudarmin et al., 2019) and critical and creative thinking skills (Sumarni & Kadarwati, 2020). However, until now, there have been no reports regarding the effect of applying the ethno-STEM PjBL model in physics learning, primarily related to the concept of fluid on solving problems and assessments that require higher-order thinking skills. Therefore, this study aims to determine how implementing ethno-STEM PjBL affects higher-order thinking skills and misconceptions about several physics concepts. In addition, this research is urgent to determine the relationship between the increase in higher-order thinking skills and misconceptions about several physics concepts. The formulation of the problem in this study is as follows: (1) What is the description of students' high-level skills and misconceptions about physics?; (2) How does applying the ethno-STEM PjBL affect students' high-level skills and physics misconceptions?; (3) What is the relationship between high-level skills and students' misconceptions about physics?

METHODS

This research was conducted using a pre-experimental method using a pretest-posttest control group design. The research sample is an eleventh-grade high school from a South Sulawesi school where most students have much life-related knowledge and experience in Lake Tempe. There were 39 students in the sample, and 12 were selected to participate in focus group interviews based on their responses to the PAT. This interview is expected to strengthen and convince researchers of the findings from PAT analysis results. The data collection technique used in this study is a test. There are two types of tests: pre-post achievement test (Pre-Post Achievement Test/PAT) to determine whether there is an increase in higher-order thinking skills and Three Tier-Test to find out the decrease in the level of misconceptions after the implementation of Ethno-STEM-PjBL. The data obtained were analyzed descriptively by describing the completeness and achievement of high-level thinking skills in each aspect and the level of misconceptions in physics.

At the initial research stage, we made direct observations of several schools around Lake Tempe, the characteristics of students, and mapped students who directly connected with Lake Tempe activities. However, due to the increasing cases of COVID-19 and the re-closing of several schools, research was carried out in other schools by assuming the problems experienced by the same students and also that the majority of students at these schools had adequate understanding and experience of activities at Lake Tempe. Purposive sampling was used, where samples were taken from students who knew about the activities and life of Lake Tempe and had visited the place.

The Three-Tier Test consists of 30 items. The high-order thinking skills test has ten items which consist of analysis (C4), evaluation (C), and creation (C6). This test was developed from various textbooks and modified by adjusting the physics concepts related to Lake Tempe. In addition, this test instrument has undergone content and construct validation and is suitable for use. The instrument reliability test uses Alpha-Cronbach with a value of 0.78 which indicates a reliable instrument. Interviews were conducted with 12 random students to support the analysis results. Each question in this interview aims to determine whether the students' answers follow the circumstances and whether students can describe their misconceptions and skills. The data obtained from the PAT and Three-Tier Test, both initial and final, were then analyzed. The N-Gain test is carried out with the following equation to see if there is an increase in the HOTS level (Sumarni & Kadarwati, 2020).

$$\%N - Gain = \frac{Score\ of\ Posttest - Score\ of\ Pretest}{Maximum\ Score - Score\ of\ Pretest}$$

Meanwhile, to find out how to reduce misconceptions, the DQM equation is applied (Kurniawan et al., 2019; Kurniawan et al., 2019).

$$\%DQM = \frac{Score\ of\ Pretest - Score\ of\ Posttest}{Score\ of\ Pretest - Ideal\ Score}$$

To determine the criteria for increasing higher-order thinking skills and decreasing misconceptions using the same percentage of N-Gain and DQM as in Table 1 (Kurniawan et al., 2019; Sumarni & Kadarwati, 2020).

Table 1. Criteria for Increasing HOTS and Decreasing Misconceptions

N-Gain or DQM (%)	HOTS Increase Criteria	Misconception Reduction Criteria
70<%≤100	High	High
29<%≤70	Medium	Medium
%≤100	Low	Low

The misconception is determined by students' answers for each level of the question, as in Table 2 (Pesman & Eryilmas, 2010; Suryadi et al., 2020).

Table 2. Categorization of the Types of Students Answer

Level 1	Level 2	Level 3	Category
True	True	Sure	Scientific Knowledge
True	False	Sure	Misconception
False	False	Sure	Misconception
False	True	Sure	Error
True	False	Not Sure	Lack of Knowledge
False	True	Not Sure	Lack of Knowledge
True	True	Not Sure	Lack of Knowledge
False	False	Not Sure	Lack of Knowledge

RESULTS AND DISCUSSION

The research was initiated through the development of Student Worksheets (LKPD) and Concept Understanding Instruments (PAT), which consisted of higher-order thinking skills (HOTS) and misconceptions test instruments using the three-tier test. Including providing the equipment, students need to work on projects per the given physics concepts. Essential questions provide an overview of students' initial knowledge regarding their everyday environment. This essential question is used as a teacher's exploration material about understanding the concept that will be implanted by conducting questions and answers in front of the class.

The teacher directs students to carry out a project by providing direction related to achieving goals. This goal should emphasize the position of the four elements of STEM. Then students plan by looking for various information about completing the given project. Students discuss in groups the design of the stages of project completion, seek information about the completion and obstacles in project implementation, the maximum time required for project completion, and create projects by integrating STEM components. In making a project plan, students can use several learning resources as facilities in project planning and make it easier to find information during the implementation of learning activities. The teacher provides the equipment and materials needed in this lesson.

In compiling a project completion schedule, students must be directed to create a schedule timeline so it is easy to plan. The timeline aims to arrange the scheduling to make it easier and more focused following the agreed project stages. Students must be able to complete the project within the agreed time. They can discuss this schedule with their group. Teachers must check and provide directions related to the schedule that students have prepared. The teacher must see the time's appropriateness at the project's completion. If students work together to complete a project, the teacher monitors the progress in person or online. Monitoring students' activities during the learning process and seeing the project progress aim to determine how far they can complete the project according to the timeline.

To complete project-based learning, students must follow the stages in the LKPD and complete each topic outcome by integrating STEM, as shown in Table 2. This stage is carried out by the teacher testing and evaluating students' products. Students test and assess the products they make. Testing the products they develop will lead to analyzing, evaluating, and creating concepts and essential questions previously given. Teachers and students conduct discussions to encourage students to find answers to various problems.

The eight innovative concepts are selected based on a study of physics concepts directly related to the lives of students around Lake Tempe. For students to learn with the Etho-STEM-project-based learning model, which is quite complex in learning management, the role of learning modules and visual aids provided by eight tutors is very important.

After completing eight projects related to physics concepts they encounter in everyday life, students are asked to do the Post-Achievement Test and Three-Tier Test.

Table 3. Integrated Project Assignment with Ethno-STEM in Project-Based Implementation Learning

Project Topic	Project Tasks integrated with Ethno STEM PjBL
Miniature Houses/ Floating boats and support boats	**Science**: The concept of gravity, buoyancy, and balance
	Technology: Using the suitable materials in making miniature houses and boats (Making miniature houses and boats)
	Engineering: Adding the load and determining the position of the floating beam. (thinking of ways to prevent the house/boat from sinking)
	Mathematics: Calculating gravity, buoyancy
Miniature motorboats and sailboats	**Science**: The concept of buoyancy and velocity
	Technology: using dynamos (motors) and batteries in making motorized boats and sailboats
	Engineering: determine the motor and screen position (size) for maximum speed
	Mathematics: calculate boat speed
Fish Slingshot	**Science**: The concept of elasticity and Hooke's law
	Technology: using technology to make fish catapults
	Engineering: determine the size of the rubber and the position of the hook
	Mathematics: calculate rubber constant and rubber potential energy
Pulley on a conical net	**Science**: Mechanical advantage concept
	Technology: make a conical load system hanging using a pulley
	Engineering: determine the position of the pulley and the size of the rope
	Mathematics: calculate the mechanical advantage of the pulley
Fish trap	**Science**: The concept of floating, sinking, and floating (Archimedes principle)
	Technology: Making fish traps from bamboo, paralon, and existing equipment
	Engineering: determine the position of the traps and the distance between the traps
	Mathematics: calculate the density of an object
Zinc/ Roof	**Science**: Light reflection concept
	Technology: make the roof of the house of shiny zinc
	Engineering: determine the color of the roof/zinc
	Mathematics: Calculate the angle of incidence and angle of reflection
Drinking water distillation	**Science**: the concept of heat (heating and evaporation)
	Technology: Make a simple drinking water distillation device using existing equipment
	Engineering: Glass position and size
	Mathematics: determine the debit of distilled ice
Traditional lamp	**Science**: Capillarity concept
	Technology: Making a lamp using oil and a wick
	Engineering: determine the size of the capillary tube and the type of liquid
	Mathematics: calculate the water level in the capillary tube

The N-Gain values of higher-order thinking skills and DQM misconceptions after the application of Ethno-STEM PjBL are presented in the figure. From the figure, there was an increase in higher-order thinking skills, with the number of students in the low, medium, and high increase categories, 7 (17.95%), 18 (46.15%), and 14 (35.89%), respectively. Likewise, with other variables in this study, based on the picture, there is a decrease in the level of misconception experienced by students. Before determining the category of decreasing misconceptions with the DQM equation, an analysis of the number of misconceptions for each student is first carried out according to Table 2. The number and percentage of students in the low, medium, and high decrease categories are 12 (30.77%), 14 (35.89%), and 13 (33.33%), respectively. The results of this study indicate that with the application of Ethno-STEM PjBL, there is an improvement in conceptual understanding of several physics topics, with the majority in the medium category.

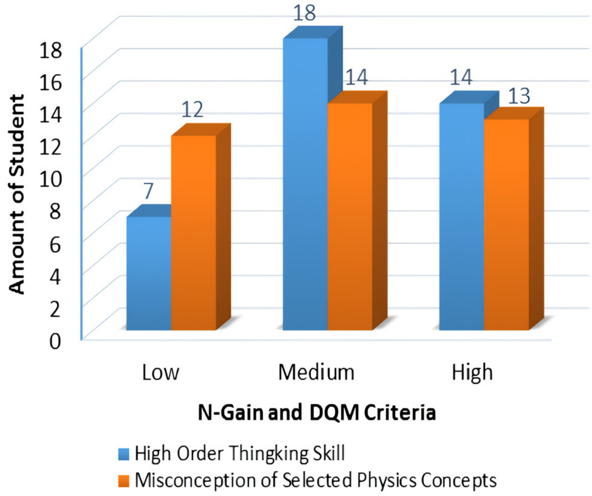


Figure 1. The Number of Students on Each N-Gain and DQM Criteria

Figure 1 shows how the N-Gain value, in general, is based on the pre and post-test results. However, if analyzed further, higher-order thinking skills are divided into three levels: analysis (C4), evaluation (C5), and creation (C6). The average pre- and post-achievement test scores and the N-Gain score for each of these indicators are presented in Figure 2

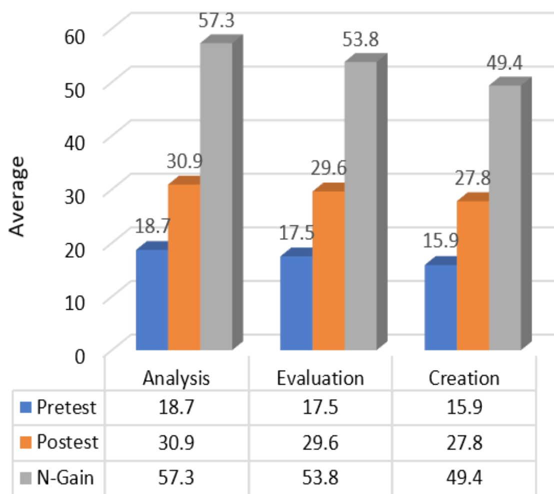


Figure 2. The Average Pre- and Post-Achievement Test Scores and the N-Gain Score for Each of These Indicators

Figure 2 shows an increase in N-gain in the medium category for the three levels of higher-order thinking. The students achieved the N-gain with the highest percentage on the analysis indicator (C4), while the N-gain with the lowest percentage was on the creation (C6) indicator. If we refer to the opinion of Limbach and Wang, which states that critical and creative thinking skills are part of higher-order thinking skills, this result aligns with what was previously reported (Han et al., 2016). In addition, it was reported that integrating the ethnoscience approach in physics with technology, engineering, and mathematics in learning can improve students' analytical skills on the given problem. In other words, applying this model can increase students' critical power (Arfianawati, 2016). It shows that achieving high indicators is possible because ethno-STEM applied through PjBL can guide students in connecting the physics concepts learned with technology in everyday life. This linkage can refer mainly to concepts related to traditional technologies that relate to students' daily lives and well-developed techniques. The major factors contributing to the favorable impact on students of any knowledge level are the practical activity and field context. If adequately analyzed, they realize that the activities and problems they encounter daily in their environment can be solved using the ethno-STEM PjBL model.

Each indicator of higher-order thinking skills is evaluated using C4, C5, and C6 question items. These indications have given a clear justification for how physics concepts are measured through questions, such as static and dynamic fluids, work, and energy systems on various equipment found and used by the community in Lake Tempe. The skill indicators of each level can be identified through 3-5 items in the essay on each topic. Most students can design boats that carry more loads, are more stable, and move faster in water. In addition, by making fish slingshots, students have found how to make the iron tip of the catapult stick deep into the fish's body. For example, a question containing creative skills (C6) is, "what is a good shape for a boat to be more stable and carry more loads?" After comparing the two shapes of the boat, the students answered, "by providing support on both sides, the boat is not easy to rock and can hold more weight than without the support."

The question to determine analytical skills (C4) is, "what is the relationship between the existence of a buffer on both sides of the boat with the ability to withstand the amount of load and is more stable?" As for the evaluation skill (C5), students were asked to evaluate the lack of support on both sides of the boat speed. Most students answered that the support gave a greater upward force because the volume of the submerged object was greater.

A correlation analysis was then carried out to answer one of the research focuses on the relationship between higher-order thinking skills and the level of students' misconceptions about physics. The correlation value between the two variables is 0.919, indicating a solid correlation between higher-order thinking skills and the level of misconceptions in physics. In higher-order thinking skills, there are several aspects, one of which is the ability to think critically. According to Michael F. Shaughnessy, higher-order thinking is an umbrella term encompassing bother critical thinking (Taft, 2015; Shen, 2016). Alternatively, in other words, one aspect that causes a decrease in misconceptions is an increase in critical thinking skills. This connection can be seen based on research results showing an increase in critical thinking skills followed by a decrease in misconceptions (Kizilcik et al., 2015; Gal-Ezer & Trakhtenbrot, 2016; Türkmen & Usta, 2016; Missa et al., 2020). It is in line with previous research, which stated that a lack of analysis and practice in solving problems which has an impact on low critical thinking skills, is a factor causing high misconceptions experienced by students (Jolley et al. 2020; Maizon et al., 2022). It can occur due to students' involvement in the learning process in poor grades, where most only receive learning from the teacher.

The application of project-based learning by integrating STEM into physics learning by relating student activities to their environment makes students much more active and enthusiastic. Students who often participate in student-centered learning can analyze and solve problems well (Jolley et al., 2020). The ethno-STEM-PjBL learning model positively increases critical and creative thinking (Sumarni & Kadarwati, 2020). Critical thinking skills can solve problems, consider making decisions, and reduce the occurrence of misunderstandings about physics material. In addition, critical and creative thinking and problem-solving skills are part of higher-order thinking skills. Therefore, this is the reason for the positive influence of the Ethno-STEM-PjBL learning model on improving high-order thinking skills.

Incorrect understanding of students can be corrected. One of the essential findings in this study is the influence of ethno-STEM PjBL on improving conceptual understanding in terms of reducing misconceptions. Most students who participated in the interviews stated that working on projects in making miniatures changed their understanding of physics concepts received at the previous education level. For example, an object can float because it has mass and volume, and the object type does not matter. It is not entirely true because even though an object has a large mass, if the volume of the object immersed in water is made large, then it can float. When students make two boats with the same mass, one is supported on the left and right, made of very light material. When the weight is added to both boats, the boat with more excellent support can accommodate and withstand more weight.

The application of project-based learning with a focus on completing physics products or teaching aids and investigations using the products is the cause of improving students' conceptual understanding. It aligns with previous research that inquiry-based learning facilitates students in cognitive conflict and conceptual inquiry through experimentation so students can correct misconceptions they experience (Taufiq et al., 2020). Previous experiences of students support improved conceptual understanding. It is beneficial because having experience gained from the surrounding environment makes it easy for teachers to explore and straighten students' understanding. In addition, the Ethno-STEM PjBL Based Student Worksheet also guides students to think critically during the learning process and evaluate and explore ideas independently and in groups. Using student worksheets helps engaged students practice their deductive reasoning, creative thinking, conceptual knowledge, and critical thinking skills. In addition, student activities through experiments using the STEM system require students to look for other information related to what they have learned through reading textbooks and other sources (Hasanah, 2020). It makes more and more activities carried out so that students support an increased understanding of the concept of glasses better.

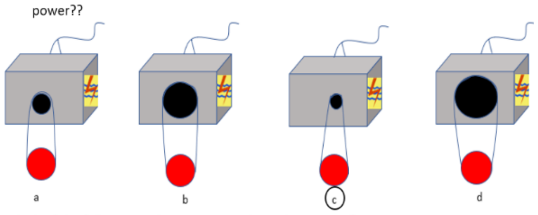
The research results in this article are under previous research, which reported that by assisting students in using their knowledge to solve issues and actualize scientific literacy with competence and creativity, STEM PjBL may help students learn more (Afriana et al., 2016; Lou et al., 2017). When the strategy improves higher-order thinking skills by training students to be critical and creative about the problems given in the learning process associated with appropriate learning objectives, appropriate learning experiences will become more meaningful, challenging, and engaging (Tambunan, 2019).

Finding solutions to every problem is through product-based projects. Students will be motivated to think more critically and meaningfully about the material they are learning if different critical and creative thinking techniques are applied to the relevant curriculum content. Students who are familiarized will be more equipped to identify issues and produce inventive solutions. They will also be more assured while sharing their findings and concepts with others. Collaboration and other soft skills can also grow by applying this learning model.

Ethno-STEM-PjBL helps students memorize physics concepts and understand science concepts and their relationship to technology, engineering, and mathematics. They also relate the concept to its application in everyday life, especially in various cultural, economic, and social elements that have survived today (Novitasari et al., 2017). The level of achievement of higher-order thinking skills is at a medium level, and the criteria are low in this study, indicating that the implementation of ethno-STEM PjBL can actualize students develop a critical and creative attitude toward various problems they encounter in learning or everyday life that are closely related to their environment. The difficulties of completing project assignments that require students to solve problems demonstrate the level of achievement of their higher-order thinking skills. Students will arrange their knowledge in PjBL collectively by trying different solutions to problems that promote critical and creative thinking (Han et al., 2016; Darling-Hammond et al., 2020).

In addition, there is a decrease in the level of misconceptions, the majority of which are in the medium category, indicating that by integrating social, economic, and cultural life encountered in students' environments with physics concepts through a product-based learning process where engineering and mathematics can improve students' understanding of concepts. Observing directly through the product shows students the effect of physical quantities on other quantities. It is essential because, so far, students have only relied on direct explanations from the teacher, which sometimes students cannot understand properly. In addition, students are more directed to solve various problems with numbers through formulas. Many students do not know the reasons for using these formulas. Through ethno-STEM PjBL, mathematics and engineering are needed to direct students in designing products and prove whether, with this knowledge, the learning materials taught so far are correct and under reality. Moreover, when faced with almost the same questions with modifications, students cannot solve these problems. For example, Figure 3 is one of the diagnostic tests for identifying misconceptions. Most students correctly answer three levels of questions, showing their scientific knowledge or a decrease in misconceptions about the concept of circular motion.

30. Some of the houses on Lake Tempe use a generator that is driven by a wheel from the engine. The picture below is a generator system that is driven by a red engine wheel. If the speed of the red wheels is the same, which generator produces the highest electric power??



Which of the following is the reason you chose that answer?

a. The smaller the diameter of the generator wheel, the greater the angular speed so that the rotation and energy generated are greater
b. The bigger the generator wheel, the greater the angular speed so that the rotation and energy produced are greater
c. The smaller the diameter of the generator wheel, the smaller the angular speed so that the rotation and energy generated are greater
d. ....

Are you sure about this reason?

a. Certain
b. Not sure

Figure 3. Problem Number 30

Before working on the project, most students had misunderstandings about this question. They answered correctly on the first question (level 1), but most students gave wrong answers about why they chose answers on question 1 (level 2). At level 3, they felt confident with the answers at level 2. After working on a dynamo boat building project where the wheels on the dynamo were made fixed while the diameter of the boat turbine was made to vary, they were able to identify how the angular speed of the rod was if the diameter changed.

Ethno-STEM-PjBL implementation cannot be separated from the teaching and learning process. The problems stated in PjBL are semi-open topics, hence there is uncertainty regarding the remedies for these problems (Sumarni et al., 2016; Pease et al., 2020). With ethno-STEM, PjBL allows students to develop possible answers by collecting and analyzing data to solve problems. With product-based activities related to students' daily lives, they are happy to be involved in real activities. They are also happy to directly observe traditional processes during the teaching and learning process. As a learning model that challenges students to study and work together with groups to find solutions to real problems (Wan et al., 2016; Bhakti et al., 2020), students' project assignments by integrating science, technology, engineering, and mathematics have stimulated them to understand the physics concepts learned in creating products (Scott, 2012; Sahin et al., 2015). This approach requires collaboration, peer communication, and independent learning. It proves that the ethno-STEM PjBL is an innovative learning approach to improve students' problem-solving skills. However, behind the successful implementation of ethno-STEM PjBL is improving higher-order thinking skills and reducing students' misconceptions about physics concepts related to students' daily activities. Most students do not know what they will observe and do not fully implement activities. In other words, teachers must be more active in project work activities, especially supervising students, so that project work goes well. Many students still need motivation from the teacher to start working on projects. In addition, a few students do not understand what they are doing and whether their work answers the problems and learning objectives because learning is still done in groups, where one or two students are still passive.

In the research conducted, there is a novelty. This novelty can be seen from applying the ethno-STEM PjBL associated with student activities around Lake Tempe and is closely related to the physics concept. In addition, the analysis of the influence of this learning model on higher-order thinking skills and misconceptions about several broader physics concepts such as fluid, elasticity, heat, light, and mechanical advantage is one of the innovations that previous researchers have not reported. In addition, no studies have analyzed the effects of higher-order thinking skills on levels of conceptual understanding or on reducing students' misconceptions about some physics concepts in school. Therefore, this research impacts overcoming students' misconceptions, especially in some physics concepts, by increasing higher-order thinking skills through project-based learning that integrates social aspects and student activities in their environment.

CONCLUSION

This study shows that ethno-STEM PjBL can increase the average high-order thinking skills on all indicators in the medium category. The analytical aspect shows an increase in the highest category, while the creation aspect shows an increase in the lowest category. There was a significant increase in HOTS skills in the medium category. In addition, implementing the ethno-STEM PjBL also reduced students' misconceptions, mainly in the medium category. The analysis results also show a solid correlation between increased students' higher-order thinking skills and decreased misconceptions about several physics concepts. The ethno-STEM PjBL application improves critical thinking, creative thinking, and problem-solving skills. It is the reason why ethno-STEM PjBL has a positive effect on higher-order thinking skills. Some of the impacts of implementing the ethno-STEM PjBL in this study are clear.

This study shows that applying this learning model encourages students to think more, analyze and evaluate information (critical thinking), solve problems, and be creative about the problems given. They can develop more meaningful concepts by connecting phenomena in their environment. Applying ethno-STEM PjBL in this study has increased students' thinking skills, such as causal thinking, predicting reasonable outcomes according to what is experienced, analyzing data from various perspectives, evaluating, and creating. These skills are developed through opportunities to frequently explore and express opinions, questions, and ideas critically and to think receptively, collaboratively, and creatively about the various problems presented. Students mainly do this while working on products from project learning and investigations with these products. Applying the Ethno-STEM-PjBL model improved students' initial concepts about glasses, which often did not match the actual concept. Integrating students' everyday experiences with physics, technology, engineering, and mathematics concepts make increasing their understanding of concepts more accessible. However, this study has limitations in research sampling in implementing activities. The samples were not students who live directly in Lake Tempe but students who only know them deeply and often visit Lake Tempe. The study's results would be different if the sample used were students who live and do activities daily in Lake Tempe. Therefore, further research needs to be carried out by taking different samples and focusing on students who live in Lake Tempe.

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