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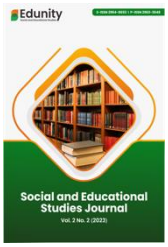

APPLICATION OF SELF-DIRECTED PROBLEM-BASED LEARNING TO IMPROVE HIGHER ORDER THINKING SKILLS IN VOCATIONAL EDUCATION

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ABSTRACT

21st-century Learning provides profound changes in the learning process in school because students must control their Learning to increase their critical thinking and problem-solving skills. The statement above, in line with Malcolm Knowles's research results, states that Self-directed Learning can improve students' critical thinking through intuition and analysis experience. The problem is that in vocational education, students emphasize hard skills and practice. Learning 21st-century demands that students have soft competency to influence how they think in making decisions. Therefore, the researcher aims to determine the effect of the self-directed learning model on the students' higher-order thinking Skills in Vocational Education. The method used in this research is quantitative, using two groups, namely the experimental class and the control group, with 34 students in each class. Class Experiments get treatment of self-directed Problem-based Learning that has been developed, while the control class did not get this treatment. This learning model is applied to the Mechanics Technique Subject; then, the post-test learning outcomes are independent sample t-tested using SPSS to determine the significant effect on higher-order thinking skills in the transfer knowledge aspect. This study found that Self-directed Problem-based Learning positively impacts Higher-order Thinking Skills in Vocational Education, which can be seen from the t-test results more than t-table (3.807>1.668).

Keywords: Self-directed Learning, Problem-based Learning, Higher Order Thinking Skills, Vocational Education.

Introduction

In the fourth industrial revolution era, education is expected to prepare human resources equipped with 21st-century skills, one of which is Higher Order Thinking Skills (HOTS). These skills include analyzing, evaluating, and creating, which are crucial in facing global challenges. Vocational education, which aims to prepare skilled and industry-ready workers, must also facilitate the development of HOTS among its students. However, implementing HOTS development in vocational education still needs challenges, such as the lack of suitable learning approaches to cultivate these skills. Problem-based Learning (PBL) is

one of the pedagogical approaches that has proven effective in enhancing HOTS (Barrows, 2019). This approach encourages students to actively engage in solving real-world problems, which not only enhances conceptual understanding but also critical and creative thinking skills. However, the success of PBL implementation heavily depends on students' ability to direct their learning process, known as Self-Directed Learning (SDL) (D. et al., 2019). In vocational education, where students often face learning situations that demand direct practice and application, combining SDL and PBL can be an effective strategy to improve HOTS.

Through SDL, students are encouraged to take responsibility for their learning process, from setting goals and finding resources to evaluating learning outcomes. Thus, the application of SDL within the PBL framework is expected to optimize the learning process and enhance the higher-order thinking skills of vocational students. Research on PBL and HOTS has been widely conducted in various educational fields. According to Barrows (2019), PBL is an effective learning method to enhance critical thinking skills because students are encouraged to face real-world problems and solve them through analytical reasoning. Additionally, a study by (C. et al. and S. Hmelo-Silver, 2020) found that PBL not only improves critical thinking skills but also promotes collaboration among students and the development of communication skills. On the other hand, SDL is considered an essential skill in 21st-century learning contexts. According to research (Knowles, 2020), students with good SDL skills can better manage their learning processes and are more likely to succeed in problem-based Learning. A study (Garrison, 2020) also found that students with high SDL capabilities are likelier to engage in independent Learning and achieve better learning outcomes.

Several studies have also combined the SDL and PBL approaches in education. For example, a study by (S. et al. D. Loyens, 2020) showed that combining SDL and PBL in higher education can enhance students' ability to solve complex problems and develop HOTS. However, more specific studies in the context of vocational education remain limited. Therefore, this research aims to examine further the effectiveness of SDL implementation within the PBL framework to enhance HOTS in vocational education students. Constructivism theory underpins PBL, where the learning process is viewed as the construction of knowledge by students through interaction with their environment. According to Piaget (1972), students learn by building new understandings based on prior knowledge, which occurs when they engage in exploration and problem-solving activities. Vygotsky (1978) added that Learning is also influenced by social interaction and support from others, which in the PBL context takes place through collaboration among students in solving problems.

In addition, self-directed learning (SDL) theory, as proposed by Knowles (1975), is also relevant to this research. SDL is a process in which individuals take the initiative, with or without the help of others, to diagnose their learning needs, formulate learning goals, identify learning resources, select and implement appropriate learning strategies, and evaluate their learning outcomes. In the context of PBL, SDL plays a crucial role because students are required to be more independent in seeking solutions and managing their learning process. In education, higher-order thinking concepts generally refer to the cognitive domain spacing

in the book Taxonomy of Educational Objectives, Handbook I: knowledge, understanding, application, analysis, synthesis, and evaluation. Anderson and Kartwohl then revised Bloom's Taxonommi by classifying them into six cognitive levels, namely Remembering (C1), Understanding (C2), Applying (C3), Analyzing (C4), Evaluating (C5), and Creating (C6). This cognitive framework for thinking is then used to identify hierarchical development in the information processing cognitive level from a lower level to a higher level and differentiate low-level and higher-order thinking skills (C. et al., 2019). In line with the effort to improve students' higher-order thinking skills, to know the results of the improvement process, higher-order thinking skills are obtained from the results of learning learners after participating in the activity learning. Learning outcomes were obtained from the post-test at the end of the lesson. Evaluation learning reflects the level of thinking skills using Bloom's taxonomy aspect, which Anderson and Krathwohl revised. Aspects that fall into the higher-order thinking category include analysis, evaluation, and creation. Therefore, the assessment of Learning, which is used to determine the achievement of learning outcomes, must refer to these three aspects(Knowles, 2019).

The role of the teacher in implementing the 2013 curriculum provides changes to the learning process for teachers. It is increasingly qualified to carry out activities in the 21st-century learning process, which includes critical thinking, creativity, collaboration, and communication (Loyens, 2020). The application of 21st-century Learning aims to improve education quality to answer internal and global challenges. However, this is contrary to the results of observation and interviews with teachers in vocational education, where an image that always returns to the same problem is a weak understanding of teachers regarding the importance of teaching higher-order thinking skills and the selection of learning models appropriate to enhance students' intuition (M. Yasmin, 2019). The above problems are exacerbated by interviews with several students in vocational education, namely, weakness in learning awareness due to the student's tendency to receive information from the teacher rather than engage in independent literacy. This is considered an indicator of weak student self-reflection in the learning process (Barrows, 2020). In addition to the problems in the bag, the pre-test score on engineering mechanics subject based on higher-order thinking skills showed a low mean score of 65.

Apart from the above problems, the observations show that some vocational education emphasizes hard skills or practice, even though in 21st-century Learning, students must also have soft skills to improve their quality of life (Garrison, 2019). Due to this, designing the learning model, especially in mechanics techniques, is necessary to improve and increase the level of higher-order thinking skills in vocational education. This competence is essential to equip students after graduation schools later to be able to compete and develop following the changing times. They are learning inspirational and innovative needs that must be created according to technological developments so students can follow the changing times (Jerome, 2017). Vocational education students must be active and creative in Learning to develop independence. At the same time, the teacher is a facilitator who encourages his enthusiasm for learning by applying centered learning to students. Student-centered Learning, which trains critical thinking and creative learners, is self-directed. Hence, it is self-directed Problem-

based Learning needs to be used in learning to increase the higher-order thinking skills of vocational education students. Higher-order thinking skills are one component of creative thinking and critical thinking skills. Creative and critical thinking can make someone more innovative, creative, ideal, and imaginative. When learners know how to use these skills, they can think, but some students must be encouraged, taught, and helped to apply higher-order thinking (Hmelo-Silver, 2021). One of the learning models that can develop students' critical thinking skills in completing a problem based on their experience is through Self-directed Learning. Self-directed Learning is a form of study that shapes each individual to have confidence and the capability to undergo a process that must be studied and tried. The idea of the importance of deep thinking learning entered a new era when a philosopher as well as an educational figure, John Dewey, said opinion about the importance of training students with reflective thinking ability, which was then adopted by many academic institutions in several countries within developing thinking in learning programs school.

This research provides new insights into vocational education by combining two approaches, SDL and PBL, to enhance HOTS (Loyens, 2019). While much research has discussed the benefits of SDL and PBL separately, studies that specifically examine the effectiveness of combining the two in vocational education still need to be made available. Therefore, this research is expected to fill that gap and provide new insights for vocational education practitioners on optimizing Learning to develop HOTS among students. This research examines the effectiveness of self-directed problem-based Learning in improving higher-order thinking Skills (HOTS) among vocational education students. Specifically, this research seeks to Identify the impact of Problem-Based Learning (PBL) on the development of HOTS among vocational education students, Assess the role of Self-Directed Learning (SDL) in strengthening students' ability to direct their learning processes within the PBL context, Explain the interaction between PBL and SDL in facilitating the development of HOTS among vocational education students, Provide practical recommendations for vocational education instructors in implementing SDL and PBL to enhance learning quality and students' skills.

Research Method

This study uses a quantitative approach by trying Self-directed Learning in vocational education. To obtain the desired results, systematic work planning is needed. This research procedure consists of four stages: Define, Design, Develop, and disseminate.

Stage 1: Definitions

We started the research by observing the learning process of mechanics techniques subjects in vocational education. This aim was to analyze student needs and solve existing problems. The results of this stage were obtained as preliminary data to plan a learning model based on school conditions.

Stage 2: Planning

We began to develop a learning outcome assessment based on higher-order thinking skills regarding transfer knowledge. This assessment will evaluate students' cognitive abilities in engineering mechanical subjects.

Table 1. Indicators of Higher-order Thinking Skill Assessment Knowledge Transfer Aspect

Aspect	Indicator
C2	Explain the meaning of trusses
C3	Classify the types of trusses
C4	Analyze rod force properties
C4	Analyze the rod force balance
C5	Calculate the support force
C6	Calculate the rod force acting on the truss and determine the nature of the rod force.

Stage 3: Development

At this stage, we begin to develop and try out self-directed Learning based on the problem. This Learning is suitable for engineering mechanics subjects because it aims to develop critical thinking skills. What skills can be improved by giving issues to them to think critically are motivated to solve them? Here is the syntax of self-directed problem-based Learning that has been developed:

1. Basic orientation by giving problems about the balance of the truss.
2. Students carry out investigations with independent literacy and understand the material.
3. Students hold discussions with their groups, consisting of four students per group.
4. To train students' independence, each group member gets a different question, which they can discuss with other group members.
5. Students analyze the balance of the truss and calculate the force acting on the truss.
6. Students present their results.
7. The teacher evaluates the results of student problem-solving.
8. Students make a summary and conclusions.

Stage 4: Disseminated

We apply the Self-directed learning model to tenth-grade vocational education students, 34 of whom are in the experimental class. It is used for five weeks on engineering mechanics subjects for one basic competency, namely Truss material. After the material is complete, experimental and control classes are given a post-test of a higher-order thinking indicator to determine the effectiveness of self-directed problem-based Learning on higher-level thinking skills in the transfer knowledge aspect.

Data analysis

This research uses learning outcome data from giving a post-test-based higher-order thinking aspect for analyzed descriptive statistics that consist of mean and modus scores. Finally, the student learning outcomes in engineering Mechanics subjects carried out the

independent sample t-tested use SPSS to know the significant effect of the self-directed towards their higher-order thinking skills in vocational education.

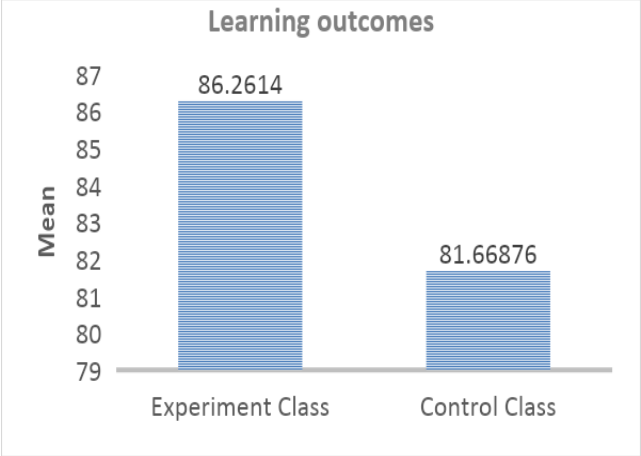
Result and Discussion

Result

Research data in the form of learning outcomes were obtained from giving post-tests on the subject of engineering mechanics. The implementation of this study used an experimental class, namely class tenth of A Modeling and Information Design the building. In contrast, the control class is class B, with the number of each class 34 students. The effectiveness of learning Engineering Mechanics subjects using self-directed Learning can be seen as follows:

Effectiveness of Self-directed Problem-based Learning

Figure 1. Comparison of the mean learning outcomes of the experimental class and control.



Based on the diagram above, self-directed problem-based Learning effectively improves students' higher-order thinking skills in transferring knowledge because the class mean experiment is more significant than the control class. Data is supported by the results of our observations on the group experiments when the learning process of student activeness is obvious. Participation of students in the learning process is outstanding because of the preparation of students in the learning process, student activity in conveying ideas or opinions during the discussion, and students' activeness in communicating the results of the debate. Students look enthusiastic about following teaching and learning activities in class. Students get encouragement to learn well because apart from getting clear orders, they also have active and responsible opportunities with personal tasks, thus creating an independent attitude. The discussion process with the teacher also went enthusiastically because each student who is a member of the group gets different types of practice questions. Then, students will be more challenged to ask friends or the teacher if they need help working on the sheet if it works. This also adds to students' insight because when discussing and there are members of his group who find it challenging to complete their tasks, the other members are obliged to solve the problem individually. This learning model also encourages students to improve their critical thinking skills because they are responsible for their work. Meanwhile,

the results of observations made in the group student activeness control are still low. This is because when students present the results of their discussion, only a few students pay attention and give feedback, even though many students still do not understand. Apart from the problems above, the learning outcomes are low. Students are also caused by each member's assignment sheet groups to get the same types of questions during processing discussion, thus causing student dependence on others and reducing their independence.

Higher-Order Thinking Skill in Transfer Knowledge Aspect

Table 2. T-test result of students' learning outcomes

Group	Mean	Variants	t-test	t-table
Experiment	86.261	24.683	3.807	1.668
Control	81.669	24.798		

Based on the table above, it can be seen that the learning outcomes experimental group got a class average score of 86.261, which is higher than the control group, which got a class average score of 81.669. This matters because, in the experimental group, which uses this learning model, the teacher delivers material to students in groups and provides assignment sheets; each group consists of 4 heterogeneous students, and each member of the group gets different types of questions on their worksheets, with this encourage students to interact with members his group to solve each problem so that more insight. In the control group, which did not get this treatment, each group member received the same questions in their worksheet, so students were more inclined to hang the results of the work of its members considered capable of completing the task; this caused students to be less motivated to solve the problem so that when doing the test there are still many students who cannot do it. From the statement above, the ability of students to solve the problem still needs to improve. Student worksheets-based problems can also help the teacher make it easy to convey the material so students can easily understand it. Besides, the student's independence can increase by providing different questions for each group member in the experimental class. Students can also be trained in responsibility for the tasks that must be completed.

This matter aims to develop student study habits, usually without a handbook and memorization, to be more creative and innovative to motivate students to learn. This is due to the learning stage of Self-Directed Learning, delivering the results of the discussion to his group and looking for information about what cannot be done by each student with the member's groups, as well as for successful students working on the problem should explain what will be asked by members of the group. In this stage, students can get more information about learning. This helps students solve problems because each group member gets different questions, so each student is responsible for every task they get; however, each group member can cooperate to solve it. If students have difficulty answering the questions they get, then the members of his group have to help, so they will exchange information to solve problems. Results t-test after applied Self-directed Problem-based Learning is more than t-table (3.807 > 1.668). It positively influences improving higher-order thinking skills in the transfer knowledge aspect of vocational education.

Conclusion

The results of applying Self-directed problem-based Learning on the effectiveness of vocational education increase student activity. The results of the observations during the learning process show that students are visible in participating in the learning activity to teach in class. They also have the opportunity to be active and responsible for their duties, thus creating an independent attitude. Students also get a broad insight because each group member gets worksheets. When a group member has difficulty solving a problem, the members must solve the issue online. This statement is proven based on the t-test results of 3,807 on student learning outcomes on truss material. So, it can be concluded that applying this learning model to improve higher-order thinking Skills in Vocational Education is a significant consequence.

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