Enhancing student learning achievement using competency-based modules on basic competencies examining the characteristics of refrigerants and lubricating oils

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Abstract. The purpose of this study was to determine the increase in student achievement using competency-based modules. The study was conducted on the subject of system and the installation of refrigeration with basic competencies examining the characteristics of refrigerants and lubricating oils. This study uses quasi-experimental research methods. Participants in this study were 60 students from the vocational high school in Bandung. The research instrument used was a test, which consisted of pre-test and post-test. Improved student achievement was analyzed using the concept of normalized gain (N-gain) based on pre test and post test score data. The results showed the use of competency-based modules can improve student learning achievement. The achievement of the post test scores of the experimental class students above the minimum completion criteria with an average post test score of 89.39, while the score of the control class was 72.42. Based on the N-Gain value there are differences between the experimental class and the control class which are 79.5 and 46.94, respectively. The use of competency-based modules has implications for improving student achievement to be more optimal. The content of interesting module materials can increase student motivation and activity in learning in the classroom.

1. Introduction

The implementation of the change of curriculum vocational high school 2013 from content-based learning to competency-based learning has an effect on the learning process in the classroom. The change of curriculum 2013 is oriented to the learning process that directs students to be able to think critically and have a balanced ability in aspects of knowledge, attitudes, and skills [1]. The competency approach requires the use of modules in the implementation of learning [2]. Modules are teaching materials written systematically [3,4], operational and directed [5,6] with the aim that students can learn independently without or with the guidance of the teacher. The use of modules causes students to be more active in the learning process (student center). The modules created are expected to be in accordance with the demands of a competency-based curriculum that includes knowledge, skills and work attitudes. The three domains (cognitive, psychomotor, and affective) must always be contained in a module in order to be an ideal module and in accordance with curriculum demands that require a competency-based learning process [7].

The influence of the use of modules in the learning process in various subject areas has been carried out by several researchers. The development of scientific learning-based modules with problem-based
learning models (PBL) to improve students' ability in the accounting learning process proved effective with a significance value of $0.007 \leq 0.05$ during the effectiveness test between the control class and the experimental class [8]. Other research results explained that the development of SETS-based modules resulted in an increase in student learning outcomes in the very strong category by 82.07% [9]. Other studies reveal an increase in students' understanding of concepts using learning modules [10]. In the development of PBL-based modules, the test results by experts and students stated that the module was suitable for use and there was an increase in learning outcomes in the affective and psychomotor domains with very good categories [11]. However, in the process of learning the system and installation of refrigeration in vocational schools in Bandung, several problems were still found. Based on interviews with teachers of subject of systems and installation of refrigeration at the vocational high school in Bandung, stated that the learning process is still conventional, where learning is still the teacher center. Students tend to be passive during the learning process in class. During the learning process, the teacher uses information sheets as teaching material. The contents of the material in the information sheets are presented in the form of sentence descriptions with a few pictures so that it looks unattractive to read. This condition has an impact on student learning outcomes.

Minimum completion criteria ($KKM$) in the subjects of system and installations of refrigeration for the cognitive domain are determined with a mean score of 75 and for skills set with an optimum achievement of 75. However, there are still students with learning outcomes under the $KKM$ set by the school. Student learning outcomes at the end of the semester examination of the subjects of system and installations of refrigeration in class A and B in the 2016-2017 academic year that have not reached the $KKM$ are 38.9%. This figure is close to half of the number students of class A and the rest has reached $KKM$. In class B, students who had not yet reached $KKM$ were 22.9%, and the rest had reached $KKM$. The appearance of low student learning outcomes reflects that there are still many students who do not understand the material provided. There is a need for solutions to help students become active during the learning process to increase student learning outcomes. The solution that can be done to deal with this problem is to use a competency-based module based on the demands of the curriculum vocational high school 2013. Therefore, the purpose of this study is to find out the increase in student achievement using competency-based modules in the subject of system and installations of refrigeration.

2. Methods

This research uses a quasi-experimental method with a quantitative approach. The research design used is the untreated control group design with pre-test and post-test. There are two groups, namely one group that gets treatment (experimental) and one group acts as a control group. In this study, the experimental group was given treatment in the learning process using learning modules, while the control group in the learning process used school teaching materials / information sheets. Participants in this study were 60 students from the Vocational high school in Bandung. The research instrument used was a test.

Analysis of student achievement improvement using the normalized gain concept (N-gain) based on pre-test and post-test score data. Normalized gain is the difference between post-test and pre-test scores. Normalized gain shows an increase in learning achievement between before and after the implementation of learning. Determination of the average value of N-gain is calculated by equation 1.

$$N \text{gain} = \frac{\text{skor posttest} - \text{skor pretest}}{100 - \text{skor pretest}}$$

(1)

To describe the criteria increasing the value average N-gain, an interpretation is used as shown in Table 1.

| Normalized Gain Average | Interprets |
|-------------------------|-----------|
| $g > 0.70$              | High     |
| $0.30 \leq g \leq 0.70$ | Middle   |
| $g < 0.30$              | Low      |
3. Results and discussion

3.1. Research results

At the beginning of the study, the teacher and the researcher discussed to determine the control class and the experimental class. Based on the discussion results, it was determined that students in the class A were 30 people as the experimental class and students in the class B were 30 people as the control class. Next, the researcher prepared a lesson plan to be implemented in each class. The learning time of the system and installation of refrigeration is allocated for 4 x 40 minutes which is divided into two meetings. The contents of the subject matter delivered are basic competencies about analyzing mechanical malfunction, such as diagnosing the causes and effects of water vapor entering the refrigeration system, analyzing malfunction in compressors and condensers, evacuating and charging refrigerants. Teaching materials used during the learning process are information sheets for the control class and competency-based modules for the experimental class. In figure 1 the learning process is shown in each class, (a) the control class and (b) the experimental class.

![Figure 1](image1.jpg)

**Figure 1.** The learning process in class, (a) the control class and (b) the experimental class.

The initial ability of students to understand the subject matter of system and installation of refrigeration can be seen from the results of the pre-test conducted before the learning process begins. Figure 2 shows the data of the pre-test results of the control class and experimental class students. The number of students who took the pre-test in the control and experiment class were 30 students, respectively. The average value of the pre-test obtained in both classes shows the results of the value under the Minimum Completion Criteria which is 58.18 for the control class and 61.82 for the experimental class. The highest values in each control class and experimental class were 86.36 and 77.27. The lowest value in each control class and experimental class is the same that is 36.36.

The results of increasing students' ability to understand subject matter in the experimental class can be seen from the post test scores after being treated using a competency-based module (figure 3). The average post test score of the control class was 72.42 while for the experimental class was 89.39. The post-test scores indicate that the average value of the experimental class given the treatment of competency-based learning modules is higher than the average value of the learning outcomes of the control class and is above the KKM value.
The results of increasing student learning achievement are measured by calculating the N-gain. Gain is the difference between the post test and pre test scores. Figure 4 shows the N-gain values of the control and experimental classes. There are differences in the value of N-gain in the two classes. The average value of N-gain in the control class was 46.94 including the medium category and the average value of the N-gain in the experimental class was 79.50 including the high category.
3.2. Discussion

Based on the results of data analysis shows that there is an increase in student learning achievement in the subjects of system and installations of refrigeration in the classroom using the learning module (experimental class). This is indicated by the N-gain value of the experimental class which is higher than the control class, namely 79.50 and 46.94, respectively. The results of increased learning achievement are influenced by the characteristics of modules that are self-instructional, where students are able to learn themselves, not dependent on others [12]. Self-learning during the learning process can occur optimally by providing material that is not too verbal, meaning the teacher's position in explaining the material directly tries to be eliminated. Explanation of the material is not too verbal using modules is one way of learning that interacts directly with the physical environment [13]. The use of modules as teaching material used in class must be as attractive as possible for students. The module must be designed systematically and attractively in order to achieve the targeted objectives according to their complexity [14]. The attractiveness of the module for students can be seen from the content of the material that must be mastered based on competence, the delivery of messages (in the form of pictures or writing) must be easily understood by students, and the module content tries to keep up with the times. In terms of preparing modules that are based on their characteristics (self instruction, self contained, stand alone, adaptive, and user friendly), they cannot be separated from things that need to be considered in developing the module itself. The things needed are certain procedures that are in line with the objectives to be achieved, clear structure of learning content, and meet the criteria that apply to the development of learning [15]. If module development is carried out according to procedure, the implementation of the application of learning modules can improve learning outcomes as can be seen in the post test data. The application of learning modules in the classroom can make students more interested in learning which can automatically improve learning outcomes [16].

4. Conclusions

The application of learning modules has an effect on improving student achievement to be more optimal. The presentation of interesting material in the learning module increases the motivation and activeness of students in learning in class. Based on data analysis and discussion, it was shown that the use of competency-based modules in this study had a good influence on improving student achievement in the subjects of system and installations of refrigeration. This is evidenced by the high increase in N-Gain in the experimental class applying the competency-based learning module compared to the control class using teaching materials provided by the school (information sheets).
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