Implementing A Module On Aluminium Casting Practices At A State Vocational High School SMKN 2 Wonosari

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Abstract. This research was aimed at investigating the improvement of students’ learning achievements by applying the module on aluminium casting practices. This was an experiment study with a Pre-test Post-test Control Group design. The population was the tenth grade students (96) of Machining Engineering at a state vocational high school SMKN 2 Wonosari and the sample consisted of students in X MA and X MC. The data were collected using observations and tests which were then analyzed descriptively. The result shows that 14 students in the control group met the minimum criteria for completeness (score 75) while in the experiment group, there were 23 students reaching the score. The mean score of the experiment group was better than that of the control group (75>69). The average of the students’ learning achievement in the experiment group increased 31%, while the gain of the control group was only 18%.

1. Introduction
The National Education System Law Number 20 Year 2003 states that education is a conscious and planned effort to realize a learning atmosphere and process so that students actively develop their potential to have a religious-spiritual strength, self-control, personality, intelligence, noble character, and skills they need. Based on the Law, education is one of the most important components, so that the role of education can make changes in behaviors for certain people who do it. Education that is expected to generate human resources who can compete in this AEC (ASEAN Economic Community) era is vocational high school. So that, the government has tried to develop generations who are expected to be able to compete in the world of work and in the AEC era through vocational education or vocational high schools.

In addition, according to the Decree of the Directorate General of Primary and Secondary Education, The Ministry of Education and Culture of the Republic of Indonesia, Number 4678/D/Kep/M/2016, the field of technology and engineering includes 13 expertise programs. The skill in metal castings is one of the mechanical engineering competencies needed by manufacturing industries today. For example in automotive industries, casting techniques have been applied to produce spare parts due to the efficiency reasons. However, other competencies are still employed to support the production system. Based on the reality, there are many vocational high schools that have not applied the metal casting practices in the Mechanical Technology subject; only a few vocational high schools have.
Most schools only provide more theories instead of facilities and devices to support the casting practices.

Aluminum casting devices to meet the learning needs have been developed by Arianto (2017) in SMK Muhammadiyah 1 Salam, SMKN 3 Yogyakarta, and SMKN 1 Magelang for the Mechanical Engineering expertise program. The devices include a 5 kg aluminum melting furnace and LPG fueled with a heat source from a high pressure gas stove. Also, he has developed the sand molding equipment which includes: sand grading, pattern puller, sand compactor, sand pad, print frame, sand spoon, spoon, sand sieve, brush, sand storage, air holes, and down channel pattern. Furthermore, the melting and pouring equipment include non-fixed crucible, fixed crucible, ladel, slag sweeper and 12 kg LPG gas, and 150 kg molding sand from Ceper, Klaten.

One of the casting practice devices is a crucible furnace, which has been developed by Ilyas (2017) for the practicum media in SMK Muhammadiyah 1. The furnace as the product was assessed by a material expert, media expert, vocational school teacher, and students. Based on the assessments, the furnace was categorized as very appropriate for learning in vocational high schools.

SMKN 2 Wonosari is known to have a Mechanical Engineering Department, with Machining Technique and Welding Technique concentration programs. In addition, SMKN 2 Wonosari has implemented the 2013 curriculum, in which the curriculum provides a subject of Metal Casting Practices. SMKN 2 Wonosari provides facilities that are quite complete and modern. One of the practicum devices is a crucible furnace for aluminum castings. However the module on aluminum casting practices is not available. On the other hand, Steven (2017) has developed a module on aluminum casting practices in SMKN 1 Magelang. Unfortunately, although the module is appropriate, it has not been implemented in the learning process.

According to Yudhi (2013), a module is a teaching material that can be used by students to study autonomously with a minimum help from others. In line with this, according to Tohari (1978: 9) a module is the smallest unit of the teaching and learning program that outlines several criteria namely instructional objectives to be achieved, topics that will be used as the basis of the teaching-learning process, subject matters, position and function of the module in a broader program system, teacher’s roles in the teaching and learning process, tools and sources to be applied, learning activities that must be carried out by the students, work sheets that must be filled by students, and evaluation programs that will be carried out.

Tohari (1978: 15) claims that a module has several characteristics such as: 1) self-instructional, students can learn autonomously using the module; 2) self-contained, it provides opportunities for students to learn the complete learning materials because they are well organized; 3) stand alone, the students are not dependent and should explore other media to learn and/or do tasks in the module; 4) adaptive, the module can be used in a certain period of time; and 5) user friendly, the module is widely used by the users.

Based on the description above, this study is intended to overcome the problem that existed in SMKN 2 Wonosari which has not provided the learning module although the practicum device of aluminum castings, a crucible furnace, is available. The module that Steven has developed (2017) is adjusted according to the students’ needs in SMKN 2 Wonosari. The solution proposed is to implement the module developed by Steven (2017) to find out the students’ learning achievements in the school.
2. Method

2.1 Type of Research
This study is experimental research using a quantitative approach. It means that it fulfills all the requirements to test a causal relationship. The experimental research typically uses a specific approach; the specification is shown by two things. Firstly, the experiment research directly investigates the effects of a variable on another variable. Secondly, it examines the hypothesis of a causal relationship (Nana, 2013: 194).

2.2 Research Setting
The research was carried out from February 19 to March 9, 2018. It was conducted at SMKN 2 Wonosari which is located on KH. Agus Salim Street, Ledoksari, Kepek, Wonesari, Gunung Kidul regency, Yogyakarta Special Region.

2.3 Research Subject
The research subject was the students of class X MA and X MC Machining Engineering in SMKN 2 Wonosari, each of which consisted of 32 students. To obtain the research subject, the researcher employed a random sampling technique. (Sugiyono, 2011: 118).

2.4 Procedure
This experimental study used a Pre-test Post-test Control Group Design with two groups selected using a random sampling technique. Then, a pre-test was conducted to find out the initial condition of whether there was a difference in competencies between the experiment and control groups. The control group was only given the material in the form of Power Point slides while the experiment group was provided a treatment through the learning module as the teaching material. The research procedure can be explained in Figure 1.

2.5 Data, Instrument and Data Collection Technique
The data were obtained using the instrument in the form of questions on the ability of the aluminum casting material implemented at the pre-test and post-test. The research data were in the form of scores taken from the pre-test and post-test of the two groups. In this study, the questionnaire was used to find out the appropriateness of the module to be applied in learning and data collection.

2.6 Data analysis Technique
The data were analysed descriptively by calculating the values of mean (Me), Median (Md) and Mode (Mo). To find out the mean, the researcher employed Equation 1 (Sutrisno, 2015: 46):

\[ M = \frac{\sum X}{N} \]

\[ \text{.......................... (1)} \]
Description:
M = Mean
$\Sigma X$ = total of X values
N = Number of Individuals

To calculate Median (Me), the researcher used Equation 2 (Sutrisno, 2015: 55):

$$Median = Bb + \left[ \frac{1/2 N - Cfb}{fd} \right] i$$

Description:
Bb = Lower interval limit
Cfb = Cumulative frequency
fd = Frequency
I = Interval length
N = Number of Individuals

Moreover, to calculate the Mode (Mo) or the score that often appears, the researcher used a method to find it. It is done by counting directly on the data or by directly looking at the number of frequencies (Sutrisna, 2015: 64)

3. Research Findings And Discussion
The subject of the control group consists of 32 students. Based on the results of the pre-test, the highest score that was obtained by students is 65 and the lowest score obtained by students is 30. The average score that can be achieved by students in the pre-test is 43; the median is 45, and the mode equals to 40. The distribution of the pre-test scores of the control group can be seen in Table 1.

Table 1. Distribution of the pre-test scores (Control Class)

| Interval | Frequency | Percentage (%) |
|----------|-----------|----------------|
| 30 - 35  | 3         | 9.4%           |
| 40 - 45  | 12        | 37.5%          |
| 50 - 55  | 12        | 37.5%          |
| 60 - 65  | 5         | 15.6%          |
| Total    | 32        | 100%           |

The results of the pre-test show that there were no students who achieve the minimum criteria for completeness (score 75). The students had scores below 75.

Then from the results of the post-test in the control class, the highest score obtained by the students is 85 and the lowest score is 50. The average score (mean) achieved by students is equal to 69; the median is 70; the mode is 65. The frequency distribution of the post-test results of the control group can be seen in Table 2.

Table 2. Distribution of the post-test scores (Control Class)

| Interval | Frequency | Percentage (%) |
|----------|-----------|----------------|
| 50 - 55  | 2         | 6.3%           |
| 60 - 65  | 10        | 31.3%          |
| 70 - 75  | 10        | 31.3%          |
| 80 - 85  | 10        | 31.3%          |
The results of the post-test indicate that there are 14 students experiencing the score improvement that meet or exceed the minimum criteria for completeness (score 75). Those who do not reach the score are 18 students. The students who pass and do not pass the minimum score can be seen in Figure 2.

![Pie diagram of the students who pass and do not pass the minimum criteria for completeness](image)

**Figure 2.** Pie diagram of the students who pass and do not pass the minimum criteria for completeness (Control Class)

The subject of the experiment group consists of 32 students. From the results of the pre-test, the highest score that can be obtained by students is 60 and the lowest score is 25. The average score (mean) is 51; the median is 52.5; and the mode is equal to 55. The distribution of the pre-test scores of the experiment group can be seen in Table 3.

**Table 3.** Distribution of the pre-test scores (Experiment Class)

| Interval | Frequency | Percentage (%) |
|----------|-----------|----------------|
| 25 - 30  | 3         | 9.4%           |
| 35 - 40  | 6         | 18.8%          |
| 45 - 50  | 15        | 46.9%          |
| 55 - 60  | 8         | 25.0%          |
| **Total**| **32**    | **100%**       |

The pre-test result shows that there are no students who are able to achieve the minimum criteria for completeness (score 75).

Based on the results of the post-test, the highest score obtained by the students was 85 and the lowest score was 60. The average score (mean) is 75, the median is 75; and the mode value is 75. The frequency distribution of the post-test results of the experiment group can be seen in Table 4.

**Table 4.** Distribution of the post-test scores (Experiment Class)

| Interval | Frequency | Percentage (%) |
|----------|-----------|----------------|
| 60 - 65  | 6         | 18.8%          |
| 70 - 75  | 15        | 46.9%          |
| 76 - 80  | 8         | 25.0%          |
The post-test result shows that there are 23 students who have achieved the minimum criteria for completeness (score 75) and 9 students who have not reached the score. The students who pass and do not pass the minimum score can be seen in Figure 2.

| Score Range | Count | Percentage |
|-------------|-------|------------|
| 85 - 90     | 3     | 9.4%       |
| Total       | 32    | 100%       |

| Score Range | Count | Percentage |
|-------------|-------|------------|
| 85 - 90     | 3     | 9.4%       |
| Total       | 32    | 100%       |

The post-test result shows that there are 23 students who have achieved the minimum criteria for completeness (score 75) and 9 students who have not reached the score. The students who pass and do not pass the minimum score can be seen in Figure 2.

![Pie diagram](image)

**Figure 3.** Pie diagram of the students who pass and do not pass the minimum score (Experiment Group)

### 3.1 Sign Test

The researcher conducted a sign test on the pre-test questions to know that the final column contains a sign (Xi-Yi) which gives h=20. The least occurring sign is a negative sign, with n=32 and α=0.05. From the Table XIX, the htable value is 9, so H0 is accepted because the value of hcound is greater than that of htable. Based on the T-Test, H0 is accepted because the hcound value is greater than that of htable. It means that there was no difference in the students’ learning achievements when the pre-test was administered. Therefore, to measure the comparison between the pre-test and post-test of both groups, the researchers applied a significant value of 5%.

The sign test’s result on the pre-test and post-test in the control group using a significant value of 5% states that the value of Sig (2-tailed) is 0.000, which is less than 0.05. It means that there is a significant difference between the results of the pre-test and post-test. Furthermore, the result of the pre-test and post-test for the experiment group using a significant value of 5% shows that the value of sig (2-tailed) is 0.000, which is less than 0.05, so that, there is a significant difference on the results of the pre-test and post-test.

The sign test in the post-test uses a significant value of 5%. The result of the test states the final column contains a sign (Xi-Yi) which provides h=7. The least occurring sign is a positive sign, with n=31 and α=0.05. Based on Table XIX, h value is equal to 9, so that Ha is accepted because the value of hcound is smaller than that of htable.

In addition, there are 14 students in the control group who achieve the minimum criteria for completeness (score 75). Furthermore, there are 18 students who obtain the scores below 75. This result is influenced by both internal and external factors so that some students can pass or cannot pass the score (Tyas, 2017).

The internal factors include physical factors, intelligence, interests, talents, motivation, and health and readiness of students in understanding materials from the teacher. The external factors that affect the students’ learning achievement include school factors such as learning methods, school discipline, and supporting facilities for the teaching and learning process. Students who have a low gain percentage in...
Learning achievements were sleepy when given materials and they tended to be bored to record the material presented.

Students who have a higher gain percentage paid attention to the teacher’s explanation by recording each subject matter presented. The learning achievement may be influenced by internal factors including psychological aspects of students. Psychological factors which include intelligence, attention, interest, talent, motivation, and student learning readiness are low. So that, when the post-test was administered, they found difficulties in answering questions and finally the students obtained a low increase percentage.

Moreover, based on the data analysis of the experiment group, there are 23 students who meet the minimum criteria of completeness. In addition there are also 9 students whose scores are below 75. Students who possess scores which are less than 75 did not perform well in learning. They busily chatted with their classmates in the learning process of the aluminum casting practices. Regarding the influencing aspects, the learning achievement is due to the students’ internal factors.

The internal factors that affect the learning achievement include the low learning interest shown by the students in the classroom. The difference in the students’ learning achievement is influenced by the use of aluminum casting practice devices as the learning media to ease the transfer of knowledge. Therefore, the teacher’s explanation is not too verbalistic and the students easily understand the material.

The module has several characteristics to be applied in the learning process, one of which is as self-instructional (Tohari, 1978: 15). A sign test was also carried out on the pre-test and post-test questions. There was a significant difference after the research was carried out by applying the module to learn metal casting practices.

From the characteristics of the module and the results of the sign test, the implementation of the module on aluminum casting practices proves that the students show a high self-confidence when doing the post-test after using the module. It can be seen from the test results that the score frequency of each student is different.

The results of this study indicate that there is a difference in learning achievement between the control and experiment groups. This difference occurs because in the control group, the materials are presented using PPT slides and videos during the learning process, while in the experiment group, the module on aluminum casting practices is implemented. Furthermore, the students in the control group looked sleepy and found difficulties in understanding the materials during the learning process. Some students were noticed to have recorded the materials while others chatted with their peers. Whereas, the students in the experiment group used the module and videos on aluminum casting practices so that they could easily understand the material presented. In addition, the students could use the modules and videos to study autonomously at home.

High students' interest in learning the aluminum casting practices is evidenced by the students’ enthusiasm when the module and videos are implemented. Therefore, by applying the module on aluminum casting practices, the teaching method becomes more varied and the students will understand the materials better. The comparison of the percentage of the average increase in learning achievements of the control group and the experiment group can be presented in Figure 4.
Figure 4. Results of the average percentage on the learning achievement of the experiment and control groups

The gain score on learning achievement in the control group amounted to 18% while that in the experiment group amounted to 31%. This is due to several influencing factors, such as the limited explanation time, undeniable variable influences, students’ low interests, low self-confidence, unclear materials presented on PPT slides (Marsudi, 2016: 20).

The results have shown that the module developed by Steven (2017), which was claimed appropriate for learning, is then used in the study to investigate the effect of the module on the students’ learning achievement in the subject of Basic Mechanical Technology (Mechanical Engineering). The module on aluminum casting practices is regarded appropriate to be used in the learning of the basic mechanical engineering of metal casting in SMKN 2 Wonosari. The percentage of the average gain after using the module is 13%.

4. Conclusions and Suggestions

4.1 Conclusions

The results of the post-test in the control group after the treatment show that there are 10 out of 32 students reaching the minimum criteria for completenesss (score 75). Meanwhile, there are 23 out of 32 students who achieve the minimum score (75) in the experiment class. It means that the average of the students’ learning achievement in the experiment group is 75 which is greater than that in the control group (69). So that, the average increase on the learning achievement of the experiment group is 31%. It is higher than that of the control group, i.e. 18%.

The use of the aluminum casting practice module is very effective because it affects the students’ learning achievements, so that the students show a high self confidence to do the test. Furthermore, the results between the control and experiment groups show a significant difference.

4.2 Suggestions

Based on the research findings, the suggestions are as follows. Aluminum casting should be a compulsory subject to support the students’ learning achievements. The teacher explains well the material on alunnum casting practices and the device functions using the module on aluminum casting practices.

The teacher’s assistance needs to be intensively promoted so that students are able to highly engage in the learning of aluminum casting practices. There will be no students who chat with peers, sleep,
and play. Considering the limitations, it is hoped that in the future, research and development will be conducted to develop the aluminum casting practice module so that the materials described will be easily understood better by students during the lesson.

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