The Use Of Compact Crucible Furnace For Alumunium Casting Practice At Vocational High School SMK Muhammadijah 1 Playen

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Abstract. This study aims to examine the use of compact crucible furnace for the metal casting practice as a part of the Mechanical Technology subject at vocational high school SMK Muhammadiyah 1 Playen. The research method used was quasi experiment with nonequivalent control group design. The research population was all of the Grade 10 students in the Machining Engineering study program at SMK Muhammadiyah 1 Playen, with a total of 115 students. Class X MB, which consisted of 33 students, was picked as the experiment group, while Class X MC, with 36 students, was picked as the control group. Once the data were collected through observation and tests, the test scores were then analyzed with a difference test. The findings suggest that the scores of both the experiment and control groups increase with a gap of 51% and 25.89%, respectively. The mean score of the experiment group is 78.08, while that of the treatment group is 68.18. In conclusion, the experiment group has a higher score increase gap with 25.11% compared to the control group.

1. Introduction

Education has an important role in preparing quality and competent human resources. In order to produce competent graduates, it is imperative that each program study in vocation high school have an appropriate learning support that addresses the aimed competencies. Unfortunately, not all vocational high schools have the relevant and sufficient facilities or equipment to support the learning process. Thus, the support from the government is very much needed, especially the funding required to meet the schools’ learning needs.

Currently, the government is enforcing the role of vocational education by enhancing the number of proportions of vocational education. The direction of the government’s policy also takes form in the development of education services, i.e. by the provision of educational facilities such as the development of vocational institutions, recruitment of teaching staff, and other supporting educational facilities.

The metal casting technique is one of the skills or competencies that a graduate of Machining Engineering study program must possess. The learning process was conducted by providing the basic
theories, in addition to the practice of the subject in order to allow students to receive the knowledge and skills that are in accordance with the learning objectives. Vocational high schools in Indonesia still do not have the supporting equipment for the practice learning process, and only rely on the theories of the subject. As a result, the learning process tend to be less effective as the students do not have the chance to do the actual practice of their skills.

SMK Muhammadiyah 1 Playen is one of the vocational high schools in Yogyakarta Special Region that offer the Mechanical Engineering study program. With the implementation of the 2013 Curriculum, there are many subjects that the students must learn; however, due to the limited human resources and facilities, the learning needs for several subjects have become neglected. One of those subjects is the Mechanical Technology subject, especially on the metal casting submaterial.

It is crucial that all vocational high schools provide their students with not only the knowledge and theories of the subject, but also the appropriate and necessary equipment to support their study. However, in SMK Muhammadiyah 1 Playen, the students are only learning the theories as they are unable to practice the metal casting learning in the workshop due to the limited equipment. As a result, their mastery and competencies in the subject are lacking, while at the same time, the teachers are having difficulties in explaining the subject materials without doing the actual metal casting practice.

This study proposes crucible furnace as the casting equipment for the workshop based on the reviews of several studies. The equipment was developed by Ilyas (2017) as the media for practice learning in SMK Muhammadiyah 1 Salam. The result shows that the furnace was deemed feasible for vocational learning after a series of assessment and testing by the subject materials expert, media expert, teachers, as well as the students.

Compact crucible furnace has been applied as the media for practice learning at SMKN 1 Magelang by PanjiLukito (2016). The findings show that the use of the furnace has a positive impact on the students’ learning achievements in the Mechanical Technology subject, especially in the metal casting skill.

The increase difference in the control and experiment groups’ learning achievement (18% and 31%, respectively) is caused by several factors such as the limitation of time, unexpected variables, the lack of students’ interests in the subject materials, their lack of confidence in doing the tests, and their lack of comprehension on the subject materials due to the learning media used, namely the PowerPoint program (Marsudi: 2016).

The observation at SMK Muhammadiyah 1 Playen shows that teachers find difficulties in developing the students’ competency in the metal casting skill as there is neither main nor supporting equipment to practice the skill in the workshop. This problem significantly affect the students’ learning process in mastering the metal casting skill. Thus, the use or application of an aluminum melting furnace is crucial to ensure the improvement of the learning process in metal casting skill and solve the problem at SMK Muhammadiyah 1 Playen.

Based on the circumstances and problems, this study aims to examine the use of crucible furnace as the media for practice learning at SMK Muhammadiyah 1 Playen. In regards to the success of previous studies, it is hoped that the application of the learning media improve the students’ learning achievements, particularly in the metal casting skill.

2. Method
2.1 Type of Research
This study used the quasi experiment approach with nonequivalent control group design. Sugiyono (2015) states that the main characteristic of the quasi experimental design is the development of true
experimental design that has a control group, yet fails to function optimally in controlling the outer variables that may affect the experiment.

2.2 Research Duration and Setting
This study was conducted in April-May 2018 in SMK Muhammadiyah 1 Playen, Wonosari, Gunung Kidul Regency, Yogyakarta Special Region.

2.3 Research Subject
The research participants were the students of Class X MB with a number of 33 students as the experiment group, and Class X MC with 36 students as the control group.

2.4 Procedure
This study used the quasi experimental design with nonequivalent control group design. Prior to the treatment, the experiment and control groups participated in a pretest in order to learn the groups’ initial learning achievement. Once the treatment was applied, both groups participated in a posttest to learn whether the treatment has any effect on their learning achievement. The research procedure is presented in Figure 1.

2.5 Data, Instruments, and Data Collection Technique
Quantitative data in the form of the students’ test scores were used in this study. The research instruments used were the test items in the pretest and posttest. The data collection technique involved observation and the test items on the aluminum casting materials in the pretest and posttest.

2.6 Data Analysis Technique
The data analysis technique used was the descriptive statistic data analysis (Sutrisno, 2015: 46). The descriptive analysis is conducted by calculating the mean ($\text{Me}$), median ($\text{Md}$), and modus ($\text{Mo}$), while the hypothesis test was done by a difference test involving a $t$-test on the pretest and posttest scores of both groups.

The difference test is a statistics technique which aims at processing the data from the research findings in order to determine the gap or difference level between two groups of data. (Sukardi, 2012: 99). In this study, the difference test was applied on the pretest and posttest scores of both sample groups in order to learn the difference in the learning achievement.

In the hypothesis test, two independent samples were involved in the comparative hypothesis analysis, namely the null hypothesis ($\text{Ho}$), and the alternative hypothesis ($\text{Ha}$). They are described as follows.

$\text{Ho}$ = there is no difference in the student learning achievement in the control and experiment groups.

$\text{Ha}$ = there is a difference in the student learning achievement in the control and experiment groups.
The Ho is rejected when the t-value is smaller than the t-value in the table, while Ha is accepted when the t-values is greater than the t-value in the table. The t-table used as a comparison was taken from the book by Sugiyono (2015).

3. Results And Discussion

Class X MC is the control group of the study, which means that it acts as the dependent variable. There are 36 students in the control group taking the pretest. Among them, the lowest and highest scores are 27.50 and 70.00, respectively, while the mean, median, and modus scores are 52.56, 52.50, and 50, respectively. The distribution of the control group’s pretest scores can be seen in Table 1.

| Interval | Frequency | Relative Frequency (%) |
|----------|-----------|------------------------|
| 27-34    | 1         | 2.8                    |
| 35-42    | 2         | 5.6                    |
| 43-50    | 14        | 38.9                   |
| 51-58    | 11        | 30.6                   |
| 59-66    | 7         | 19.4                   |
| 67-73    | 1         | 2.8                    |
| Total    | 36        | 100                    |

From the posttest, it is learned that the lowest score is 35.00, while the highest is 80.00. In addition, the mean score is 66.18, the media score is 67.50, and the modus score is 70. The distribution of the control group’s posttest scores is presented in Table 2.

| Interval | Frequency | Relative Frequency (%) |
|----------|-----------|------------------------|
| 35-42    | 1         | 2.8                    |
| 43-50    | 0         | 0                      |
| 51-58    | 6         | 16.7                   |
| 59-66    | 9         | 25.0                   |
| 67-74    | 13        | 36.1                   |
| 75-82    | 7         | 19.4                   |
| Total    | 36        | 100                    |

On the other hand, Class X MB is the experiment group or the independent variable in the study. There are 33 students participating in both the pretest and posttest. The scores of the pretest reveal that the lowest score is 25.00, while the highest is 67.50. Additionally, the mean, median, and modus scores of the pretest are 51.89, 55.00, and 62.50. The pretest score distribution of the experiment group can be seen in Table 3.

| Interval | Frequency | Relative Frequency (%) |
|----------|-----------|------------------------|
| 25-29    | 1         | 2.8                    |
| 30-34    | 2         | 5.6                    |
| 35-49    | 14        | 38.9                   |
| 50-58    | 11        | 30.6                   |
| 59-66    | 7         | 19.4                   |
| 67-73    | 1         | 2.8                    |
| Total    | 36        | 100                    |
Table 3. The Distribution of the Experiment Group’s Pretest Scores

| Interval | Frequency | Relative Frequency (%) |
|----------|-----------|------------------------|
| 25-32    | 2         | 5.6                    |
| 33-40    | 4         | 0.0                    |
| 41-48    | 5         | 13.9                   |
| 49-56    | 8         | 22.2                   |
| 57-64    | 11        | 30.6                   |
| 65-72    | 3         | 8.3                    |
| **Total**| **33**    | **100**                |

The results of the posttest of the experiment group show that the lowest score is 62.00, and the highest is 95.00. The mean, median, and modus scores of the posttest are 78.08, 80.00, and 80, respectively. The posttest score distribution of the experiment group is presented in Table 4.

Table 4. The Distribution of the Experiment Group’s Posttest Scores

| Interval | Frequency | Relative Frequency (%) |
|----------|-----------|------------------------|
| 62-67    | 1         | 2.8                    |
| 68-73    | 4         | 0.0                    |
| 74-79    | 8         | 22.2                   |
| 80-85    | 16        | 44.4                   |
| 86-91    | 3         | 8.3                    |
| 92-97    | 1         | 2.8                    |
| **Total**| **33**    | **100**                |

The control group’s mean score increase is 13.61, while the median is 12.5, and the standard deviation is 10.53. The highest score increase in the control group is 32.5, while the overall score increase percentage is 25.89% among 36 students.

The experiment group, on the other hand, has a mean score increase of 26.29, with the median of 25, the highest score increase of 50, the lowest of 7.5, and standard deviation of 11.51. The overall average score increase in the experiment group is as much as 51.00%. The data of the experiment group’s score increase can be seen in Table 5 and Figure 2.

Table 5. The Control and Experiment Groups’ Score Increase

|                  | Experiment | Control |
|------------------|------------|---------|
| Mean             | 26.29      | 13.61   |
| Median           | 25         | 12.5    |
| Highest          | 50         | Lowest 32.5 |
| Highest          | 7.5        | Lowest -15 |
| SD               | 11.51      | SD 10.53 |
| Percentage Increase | 51.00%   | Percentage Increase 25.89% |
Figure 2. The Score Percentage Increase of the Experiment and Control Groups

The difference test is conducted on the pretest and posttest scores of the experiment and control groups by measuring the mean score difference between the groups. The purpose of the difference test on the pretest scores of both groups is to examine whether they have the same abilities, while the second difference test done on the control group is for drawing the research hypothesis.

The difference test on the pretest scores with results in the t-value of 0.323 with the df on 67 (N-2), compared to the t-table on df 67 (1.671). As the t-value is smaller than the t-table, it can be concluded that there is no significant difference between the control and experiment groups.

On the other hand, the difference test on the posttest scores between the control and experiment groups finds that the t-value is 6.137, with the degree of freedom of 67 (N-2), compared to the t-table with df of 67 (1.671). As the t-value is greater than the t-table, Ha is accepted while Ho is rejected.

In addition to the 14 students in the control group who meet the passing grade of 75, there are 18 others who do not. Nevertheless, there are two factors that can be related to the difference in the increase of the control and experiment groups’ learning achievements, namely the internal and external factors. The internal factors deal with the physical factors such as intelligence, interest, talent, motivation, and students’ readiness in receiving the lesson from the teacher, while the external factors are the school-related factors, such as the learning method, discipline, and facilities supporting the teaching learning process.

Some of the students in the control group appeared to be bored and sleepy when given an explanation on the subject. A few others, however, took notes and paid attention to the class. When compared to the factors affecting students’ learning achievements, this kind of behavior may be categorized as the internal or psychological factor. Psychological factor involves intelligence, attention, interest, talent, motivation, as well as the students’ lack of learning readiness, which causes them to experience difficulties in doing the posttest.

The increase in the students’ learning achievements is the result of the application of aluminum melting furnace as the media used for giving a clearer idea of the subject materials through practice learning. This allows students to understand the lesson better as they are directly practicing the skills they learn. Moreover, the external factor that affects the learning achievement is the school facilities, particularly regarding the workshop, which does not allow the learning process to take place optimally. The Machining program at SMK Muhammadiyah 1 Playen unfortunately does not yet have
a specific workshop for practicing the casting skill. During the study, students use a workshop with inadequate equipment to practice casting learning.

The significant difference between the increase in the control and experiment groups’ learning achievements are influenced by the application of the furnace as the media for aluminum casting practice, which helps students to understand and master the skill more efficiently.

The research findings suggest that there is a difference between the control and experiment groups’ increase in the learning achievements. This occurs as the control group only receives the aluminum casting learning material in the classroom, while the experiment group has the opportunity to practice the aluminum casting skill using the aluminum melting furnace. Some students in the control group were evidently bored and sleepy, while others talked to their classmates, although there were a number of students who in fact took notes. In contrast, the experiment group students seemed excited to learn the aluminum casting learning materials and paid full attention to the researcher’s instruction, in addition to practicing the skill using the aluminum melting furnace.

Another finding of the research is that there is a significant difference between the control and experiment groups’ learning difference with 25.11%, as calculated by the difference between the experiment and control groups’ increase in the learning achievement (51% and 25.89%, respectively).

The difference is suggested by the hypothesis test and the t-test, in which the alternative hypothesis on the difference in the increase of the control and experiment groups’ learning achievements is accepted. This study supports the existing theoretical framework, while the findings support the proposed hypothesis.

4. Conclusions and Suggestion

4.1 Conclusions

Based on the research findings, it can be concluded that the students’ learning achievements in both the experiment and control groups improve with the average score increase of 51.00% & 25.89%, respectively. In other words, it is suggested that the learning achievement of the experiment group is significantly higher than that of the control group.

The difference in the students’ learning achievements is also suggested by the mean score difference between the two groups, where the experiment group scores higher than the control group in the posttest (78.08>66.18).

4.2 Suggestion

Based on the conclusion, this study offers several recommendation for the students’ learning improvement, as well as for future studies. Firstly, it is recommended the SMK Muhammadiyah 1 Playen teachers continue to apply the use of aluminum crucible furnace in the learning process due to its positive effect on the students’ learning achievement. This method also provides an opportunity for students to practice an active learning in the investigation style, which allows them to internalize the subject materials.

Secondly, it is suggested that future studies conduct further research on the same method with more suitable research duration in order to produce a more accurate result.

Finally, it is important that the policy makers, especially the education authorities, give more attention on the learning facilities and teachers’ mastery of the metal casting subject in vocational high schools, and encourage teachers to practice a more innovative teaching method.
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