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Effectiveness of Science (Physics) Teacher Training Program on Conceptual Understanding at MTs Manado

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ABSTRACT

This study aims to evaluate the effectiveness of the physics science teacher training program in improving the understanding of physics concepts at one of the Madrasah Tsanawiyah (MTs) in Manado. Using pre-test and post-test data from 52 teachers, the Wilcoxon Signed-Rank Test was analyzed. The results showed significant improvement in trainees' understanding of physics concepts, with a p-value of 0.0004 and a large effect size (r = 0.60). These findings provide empirical evidence that the training is effective in improving teachers' conceptual understanding and can be used as a basis for developing similar programs in other regions.

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1. INTRODUCTION

The Madrasah Science Competition (KSM) is a prestigious event designed to encourage mastery of science and technology among madrasah students (Panduan pelaksanaan Kompetisi Sains Madrasah (KSM), 2019). As a national platform that tests students' abilities in various disciplines, including physics, KSM is not only a symbol of individual achievement, but also reflects the quality of education at the madrasah level (Sugiyanto, 2020).

Teacher training is an urgent need, especially in physics, given the increasingly complex and evolving learning challenges (Shulman, 1987). Teachers are expected not only to understand the theory, but also to be able to apply it in various learning contexts and competitions. Unfortunately, there are still many teachers who feel less confident or have

limitations in mastering advanced physics concept, which has an impact on the effectiveness of classroom learning and student competition results (Darling-Hammond, 2000). Therefore, this training is designed to address these needs by providing intensive mentoring and innovative learning strategies (Guskey, 2002).

The importance of this training lies in two main aspects. First, improved understanding of physics concepts among teachers will have a direct impact on the quality of classroom learning, which in turn will improve student learning outcomes (Hattie, 2009). Second, the training provides a space for teachers to share experiences and challenges, so that they can find solutions together and improve their professional skills (Loucks-Horsley, 2010). In this way, training is not only a means of improving individual skills, but also building a solid learning community among madrasah teachers (Vescio, 2008).

In the context of Madrasah Tsanawiyah (MTs) in Manado, this training has strategic value to encourage students' preparation for KSM while strengthening the quality of education in the region. Through evaluating the effectiveness of this training, this research seeks to provide data-based recommendations to improve future training programs and support the continuous development of teacher competencies (Joyce, 2002).

The main objective of this research is to evaluate the effectiveness of the teacher training program in improving physics concept understanding. Specifically, the objectives of this study include; Assessing Changes in Concept Understanding: Determining whether there is a significant improvement in teachers' understanding of physics concepts before and after attending the training, by comparing pre-test and post-test scores (Cohen, 2007), Measuring Training Success: Identifying the extent to which the training succeeded in improving teachers' ability to understand and teach physics concepts (Garet, 2001), Providing a Basis for Improving Training Programs: Provides empirical data that can be used as input to improve or enhance future training programs (Desimone, 2009), Analyzing Patterns of Improvement: Understand how score changes occurred across participants, including whether any groups experienced greater or lesser improvement (Borko, 2004) and Provide Evidence for Widespread Implementation: If the training proves effective, the research can be used to support the development of similar programs in other regions (Timperley, 2007).

METHOD

This study used a quantitative design with paired data in the form of pre-test and post-test scores from 52 trainees. As the data were not normally distributed (Shapiro-Wilk test, $p < 0.05$), the analysis was conducted using the Wilcoxon Signed-Rank Test, a non-parametric statistical method suitable for paired data (Shapiro, 1965). In addition, data visualization through histograms and boxplots were used to illustrate changes in the distribution of participants' scores before and after training.

The statistical hypotheses tested are as follows: H0; There is no significant difference between pre-test and post-test scores, H1; There is a significant difference between pre-test and post-test scores.

2. RESULTS AND DISCUSSION

The results of descriptive analysis showed an increase in pre-test and post-test scores after the physical science teacher training. The pre-test mean score was 30.77 with a standard deviation of 17.25, while the post-test mean score increased to 44.71 with a standard deviation of 21.31. The median pre-test and post-test scores also showed an increase, from 30.00 to 42.50 respectively. In addition, the maximum score of participants increased from 80.00 in the pre-test to 95.00 in the post-test, indicating that some participants managed to understand the material very well after attending the training. This increase indicates that the training had a positive impact on participants' understanding of physics concepts (Hattie, 2009).

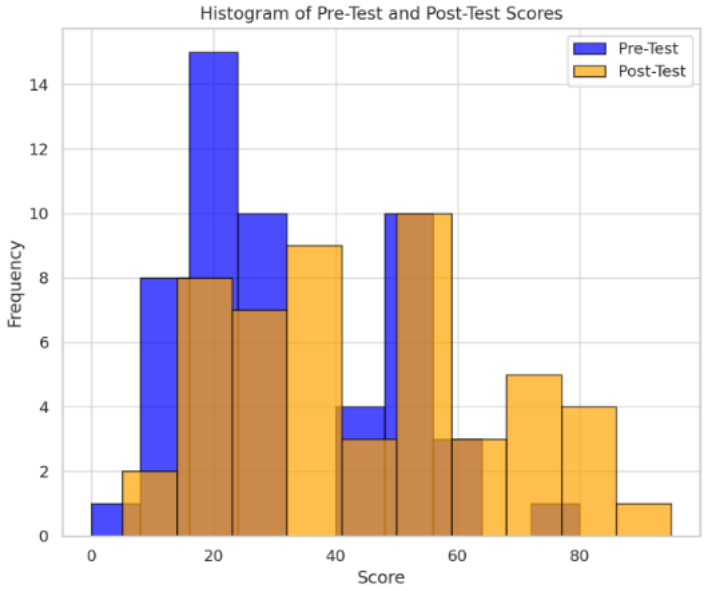


Figure 1. Comparison of Pre-Test and Post-Test Scores: An Indication of Improved Conceptual Understanding

Visual analysis using histograms showed a rightward shift in the distribution of scores in the post-test compared to the pre-test. This shift indicates a general improvement in the understanding of physics concepts after the training. In addition, the boxplot shows that the median score of the post-test is higher than the pre-test, further confirming the significant improvement. However, some outliers were found in the post-test results, indicating that there were participants with much higher scores than others. These outliers may indicate that some participants had a better level of learning readiness or were more responsive to the training methods provided (Field, 2013).

The Wilcoxon Signed-Rank Test was used to determine if this improvement in scores was statistically significant. The test results showed a Wilcoxon statistical value of 646.0 with a p-value of 0.0004. Since the p-value is smaller than 0.05, it can be concluded that there is a significant difference between the pre-test and post-test scores. In addition, the effect size obtained was r = 0.60, which indicates a large impact of the training on improving participants' understanding. In educational research, an effect size value of this magnitude indicates that the intervention had a substantial impact on the trainees (Cohen, 2007).

These results indicate that the training provided was able to significantly improve participants' understanding of physics concepts. This finding is in line with previous research showing that active-based training, such as workshops and interactive discussions, can effectively improve teachers' competencies (Garet, 2001). In addition, the success of this training can also be attributed to the learning approaches used, such as experimental and problem-solving methods, which have been shown to improve conceptual understanding in science (Hake, 1998).

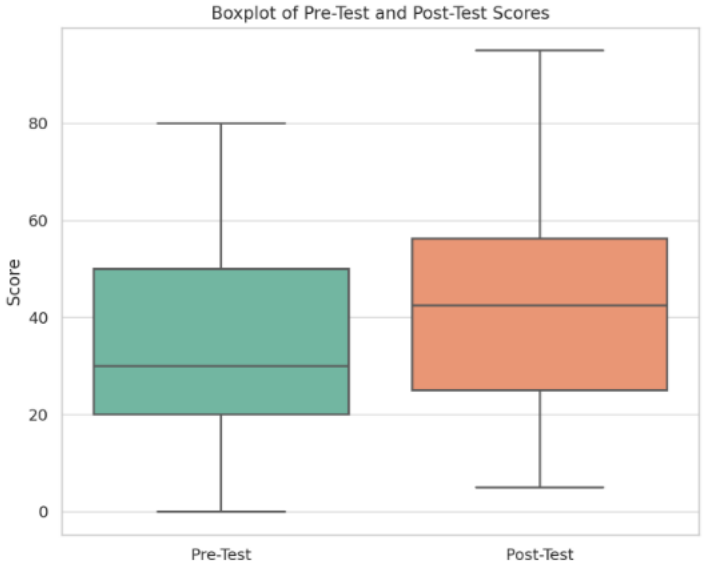


Figure 2. Comparison of Pre-Test and Post-Test Scores: Evidence of Learning Progress.

This boxplot illustrates the improvement in scores after learning. It can be seen that the median post-test score is higher than the pre-test, indicating an overall improvement in student understanding. The wider range of scores also indicates a wide variation in improvement. However, although the training demonstrated high effectiveness, there are some aspects that could be further developed. The variation in post-test scores suggests that not all participants experienced the same increase in understanding. Factors such as educational background, teaching experience and individual learning strategies may contribute to this difference (Desimone, 2009). Therefore, future trainings could be designed to be more adaptive to participants' needs, for example by providing additional materials for participants who are having difficulties or more intensive mentoring sessions for those who need them.

In addition, the long-term impact of the training also needs to be further evaluated. This study only measured participants' understanding immediately after the training was completed. A follow-up study could be conducted to see whether these improvements persist in the long term and whether participants apply their understanding in classroom teaching practices. Long-term evaluation is essential to ensure that the improved competencies gained through training actually impact the quality of student learning (Guskey, 2002).

Overall, the results of this study provide empirical evidence that the physical science teacher training in Manado is effective in improving participants' understanding of physics concepts. By considering the factors that influence the effectiveness of the training, similar

programs can be further developed to improve teachers' competencies more broadly and sustainably

3. CONCLUSION

Based on the results of the study, it can be concluded that the training to improve the understanding of physics concepts for MTs teachers in the Manado region has a significant positive impact on improving the conceptual competence of participants. This can be seen from the significant increase in the average score, from 30.77 in the pre-test to 44.71 in the post-test. Although the pre-test and post-test data did not show a normal distribution based on the Shapiro-Wilk test (p-value < 0.05), the Wilcoxon Signed-Rank Test, which is more appropriate for this condition, found that the difference between the pre-test and post-test scores was statistically significant (p-value = 0.000378). This finding indicates that the systematically designed training program was able to significantly improve the understanding of basic physics concepts. Thus, this training proved to be effective and can be recommended as a model of continuous professional development for physics teachers at the MTs, especially in efforts to improve the quality of science learning in secondary education units. The implications of the results of this study lead to the importance of organizing structured conceptual needs-based training for teachers and based on evaluation of learning outcomes. Therefore, similar training programs deserve to be expanded in scope, replicated in other regions, and adapted to the characteristics of participants in order to improve the quality of education more broadly and sustainably.

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