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The Effect of Applying Practical Work Using the Kitchen Preparation Technique to Improve Students' Concept Mastery on the Topic of Hereditary Substances

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ABSTRACT

The purpose of this study is to investigate how students' conceptual comprehension is affected when the "kitchen preparation" technique is applied in the DNA isolation practicum. A quasi-experimental design with a pretest-posttest control group is the study methodology employed. The research sample consisted of 12th-grade students from a high school in Banda Aceh, divided into experimental and control groups. The control group engaged in virtual lab learning, while the experimental group received treatment through a practicum involving kitchen preparation technique. The results of the hypothesis test demonstrated a significant difference in conceptual understanding between the experimental and control groups, with a p-value of 0.01 ($p<0.05$). This suggests that students' conceptual understanding is positively impacted by the application of the kitchen preparation technique in the DNA isolation practicum. This study confirms the value of including straightforward, affordable, and pertinent practicums in biology education, particularly for intricate subjects like genetic materials.

INTRODUCTION

As human growth, education is the primary interpretation to raise student performance for rapid developments in scientific methods in science learning and technology for building educational systems (Putri et al., 2021). In a constructivist approach to biology education, it is essential to immerse students in a series of real and meaningful experiences while fostering social interaction. This method encourages students to engage with real-world problems relevant to their daily lives, providing opportunities to build new knowledge based on their prior understanding. By linking everyday experiences with academic concepts, the constructivist approach promotes active learning and deeper comprehension as students collaboratively explore and apply scientific ideas (Rogayan, 2019). The experimental (practicum) method is one approach to biology instruction that is consistent with the constructivist viewpoint.

Students frequently rank biology as one of the more difficult disciplines to study in the classroom, particularly when it comes to the topic of hereditary substances. Adrianto (2022), in his research, clarifies that typically, due to the various foreign terms that have to be memorized, the complexity of the concepts, and the unique nature of the fabric. Furthermore, objects within the field of atomic science cannot be specifically watched with the exposed eye.

From an interview with a 12th-grade biology teacher at one of the high schools in Banda Aceh, it was learned that classroom teaching mainly relies on direct instruction, emphasizing contextual elements and memorization of concepts, especially the concept of heredity substances. As a result, the measurement of students' skills is not well-reflected. Because of the teacher's incapacity to lead practical

sessions and the restricted equipment in the school laboratory, as well as the lack of time to complete such activities, the teaching of genetics material in the classroom is not supplemented by practical activities. Yulianti (in Gasila et al., 2019) reveals that the low effectiveness of science education is due to an excessive emphasis on conceptual aspects in assessing educational success in schools.

So far, science education has tended to focus on increasing the ability to memorize and understand material, with lecture activities serving as the primary teaching strategy. This strategy eventually inhibits student participation in the learning process, worsening the situation even further. In contrast, the 2013 curriculum calls on students to actively participate in a learning process known as the student center. This process instructs students by indirectly including them in the decision-making, constructing, and development of techniques for achieving desired learning outcomes based on prior knowledge (Hamid et al., 2023).

Thus, an effective way is needed to develop mastery of basic concepts and skills based on biology learning objectives. Practical activities can be an effective solution to overcome the problems described above. Practicum allows students to be directly involved in a more active and experience-based learning process, which in turn can help improve various essential skills, such as in-depth mastery of concepts, and develop students' science process skills (Setiawan et al., 2018). Practical activities have a substantial impact on science learning and student learning motivation, providing a vehicle for building fundamental abilities in conducting experiments and scientific inquiries (Azzarkasyi et al., 2019).

There are certainly various obstacles to carrying out practical activities to improve student competence. Dewi et al. (2022) mentioned several obstacles in carrying out biology practicum activities in schools, including the unavailability of tools and materials needed for carrying out practicums, incomplete laboratory facilities, a lot of equipment that is damaged, and tools/materials that are available but never used properly. Deoxyribonucleic Acid (DNA) isolation practicum is considered challenging to carry out at school because carrying out the practice in the laboratory uses a lot of tools and equipment, is quite expensive and prone to laboratory accidents, takes a long time because it contains a lot of ingredients, and long processing steps (Silaen, 2022).

Until now, DNA extraction is often considered an activity that requires high costs and is difficult with limited resources. However, the DNA extraction process can actually be carried out with simple equipment that is easily accessible and affordable (Purwoko, 2018). The importance of displaying DNA visualization in the learning stage is so that students become convinced that DNA molecules are real entities. DNA extraction can be done simply using materials and equipment that can generally be found in the kitchen and does not require high expenses. This technique is called the "kitchen preparation" technique. With the kitchen preparation technique, the learning experience of DNA extraction can be carried out using simple ingredients without the need to follow complex preparation protocols and require sterile conditions (Kulsum & Qomariah, 2023)

DNA isolation practicum is important to learn considering the demands of Basic Competency 3.3 in Curriculum 2013, namely being able to analyze the relationships between hereditary substances, including DNA, RNA, genes, and chromosomes, in applying the principles of inheritance of living creatures. The demands of Basic Competency can be fulfilled if the teacher, in his role as a facilitator, is able to provide adequate information so that students can form an understanding of the structure and function of genes and relate it to the application of the principles of inheritance in living things (Zulfiana & Indana, 2022).

The practicum created for this study uses readily available instruments from school labs. The technique used in the practical activity that will be designed is the Kitchen Preparation technique. This technique is considered simple because it only involves standard kitchen equipment, such as spoons, forks, table salt, and other ingredients, to extract DNA. This technique is important in improving students' mastery of concepts.

RESEARCH METHODS

Research Approach

An experimental methodology with a quasi-experimental design was employed in this study. The research design employed is a control group pretest-posttest, consisting of an experimental group and a

control group. The control group will use traditional teaching techniques, while the experimental group will be treated with practical tasks related to kitchen preparation.

Research Participants

The population from which conclusions were obtained was the generalization area made up of items or persons chosen for investigation based on specific attributes and traits (Sugiyono, 2014). The 12th-grade students at one of the high schools in Banda Aceh during the academic year 2023–2024 served as the study's population.

This study employed Purposive Sampling as the sampling technique. Purposive Sampling is a method of selecting respondents as samples not based on random selection, but rather on specific purposes or certain criteria (Sugiyono, 2007). The sample was a small group representing the population that was selected as the research object. The chosen sample consisted of 12th-grade students. The sample was divided into experimental and control classes, each comprising no fewer than 15 students.

Research Instruments

The instruments utilized in this study were concept mastery exam questions and student worksheets. The 20 multiple-choice questions on the written test instrument were part of the pre- and post-test for the concept mastery exam. This test was designed to gauge how well the students understood the concepts both before and after learning. The test instrument for concept mastery covered C1 (remembering), C2 (understanding), C3 (applying), and C4 (analyzing), which were adopted from the Revised Bloom's Taxonomy.

The pre-test and post-test questions were designed to assess students' conceptual mastery before and after teaching. The instruments were then verified by the researcher using knowledgeable lecturers. Following validation, the researcher examined the pre-test and post-test questions related to concept mastery, and then analyzed and revised the tested questions.

Data Collection

In conducting the research activities, the researcher first administered a pretest to the sample class students to evaluate their understanding before the research activities began. After the initial test, both classes were given different treatments during the learning process throughout two meetings. The experimental class was handled with the application of DNA isolation practical work, employing the kitchen preparation technique, while the control class received conventional teaching methods involving the use of videos and virtual labs on DNA isolation. After both classes got their treatments, a posttest was administered to determine the level of progress gained by the students after participating in the practical exercises.

Data Analysis

The pre-test and post-test data on students' concept mastery were examined using a t-test. This test was used to assess the difference between the means of two independent samples with the assumption that the data is normally distributed. Normality and homogeneity tests must be performed prior to the t-test. These tests are required for the hypothesis test to be performed. If the data is not normally distributed, the Mann-Whitney U-test is employed as a nonparametric test. Furthermore, to determine the improvement in students' abilities from pre-test to post-test between the experimental and control classes, each student's N-Gain values are calculated, followed by a comparison of the improvement in concept mastery between the experimental and control classes. The analysis was carried out using the SPSS 25 software.

RESULTS AND DISCUSSION

Results

The research findings were summarized utilizing pretest and posttest data analysis, which included homogenity, normality, and hypothesis testing (mean difference test). Table 1 summarizes pretest and posttest scores for the control and experimental classes on the hereditary substances topic.

Table 1. Recapitulation of pre-test and post-test scores

Components	Pre-Test		Post-Test	
	Experimental Class	Control Class	Experimental Class	Control Class
Participants	30	30	30	30
Max. Score	60	60	85	70
Min. Score	10	15	25	15
Mean	34.67	40.47	65.67	55.17
Standard Deviation	14.49	11.96	14.49	11.96

Prior to conducting a hypothesis test on initial and final abilities, normality and homogeneity tests must be performed to guarantee that pre-test and post-test data from both classes are normally distributed and homogeneous. The normality and homogeneity tests revealed that the pre-test data were normal and homogenous. Thus, parametric statistical analysis using an independent sample t-test was performed. However, the post-test data were found to be non-normally distributed, necessitating a non-parametric statistical analysis using the Mann-Whitney U test. The research hypothesis reads as follows: H0 indicates that there is no difference in the average concept mastery test scores between the experimental and control classes, whereas Ha indicates that there is a difference in the average concept mastery test scores between the two groups.

The t-test on the pre-test results yielded a p-value of 0.096, which is above the significance level α (0.05). Based on the t-test results, if the p-value is above the significance level α, H_0 is accepted. As a result, the experimental and control classes have identical average pre-test concept mastery scores. In the Mann-Whitney U-test on post-test data, the p-value was determined to be below the significance level α ($0.01 < 0.05$), showing a significant difference between the two average post-test concept mastery scores between the experimental and control groups. Thus, H_0 is rejected, while H_a is approved.

The N-Gain score of each student in both classes was then calculated to determine the difference in students' abilities from the pre-test to the post-test between the experimental and control groups. A comparison of the improvement in concept mastery between the experimental and control classes was then performed. The comparison was based on the distribution of the number of students in both courses who fell into the high (N-Gain > 0.7), medium ($0.3 \leq$ N-Gain ≤ 0.7), and low (N-Gain < 0.3) categories, as shown in Figure 1.

The normality test is used to determine the normality of the data collected, guaranteeing that it may be used for statistical analysis. In other words, the normality test assesses if actual data acquired in the field is consistent with a specific distribution, which, in this case the normal distribution. The normality test operates on the assumption that data is regularly distributed if the significance value (Sig.) is larger than 0.05 (Sutha, 2019). The normality test findings show that the pre-test value in the experimental class is 0.050, while the control class has a value of 0.088. The pre-test data in both classes is normally distributed, as indicated by both values being above the significance level α (0.05). As a result, we may conclude that the pre-test data for students in both the experimental and control courses are normally distributed. The experimental class has a post-test value of 0.068, which is above the significance level α (0.05), showing that the data is regularly distributed. The post-test value in the control class is 0.041, which is less than the significance level α (0.05), indicating that the data is not normally distributed.

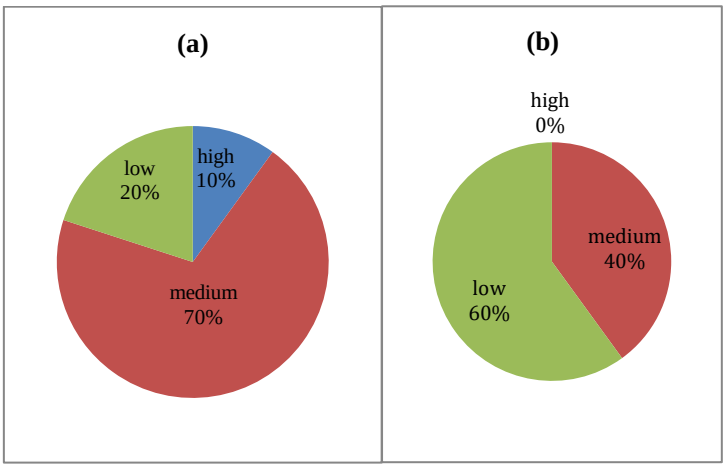

Figure 1. Comparison of the percentage of N-Gain Categorization of concept mastery between (a) experimental class and (b) control class

The homogeneity of variances test determines if the variances of two data groups are identical or not. According to (Widiyanto, 2010), the significance value (Sig.) serves as the decision-making basis in the homogeneity test. If the value exceeds 0.05, the data is considered homogeneous. However, if the significance level is less than 0.05, the data is considered heterogeneous. The homogeneity test for the pre-test data group yielded a p-value of 0.217, which is higher than the significance level α. This suggests that the differences in student learning outcome groups are homogeneous. The post-test data group's p-value (0.805 > 0.05) exceeds the significance level α, demonstrating homogeneity in the data.

A mean difference test was performed once both data groups were determined to be normal and homogeneous. There are two types of mean difference tests: parametric and non-parametric. If the data is normal and homogenous, it is tested using the t-test. However, if the resulting data is not normal and homogeneous, or if either is not normal and homogeneous, a non-parametric test is used. The results of the normality and homogeneity tests revealed that the pre-test data was normal and homogenous, hence a parametric independent sample t-test was utilized. Meanwhile, the post-test data was discovered to be non-normal but homogeneous, therefore a non-parametric Mann-Whitney test was applied.

The independent t-test is a comparison test used to determine if the mean values of two independent groups differ (Harymawan et al., 2020). Sujarweni & Wiratna, (2014) state that the significant value (2-tailed) is used to make decisions in the independent t-test. If the value exceeds 0.05, H0 is approved. If the significance level is less than 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted. The t-test findings indicate that the significance level for the pretest values of the experimental and control classes is 0.096, which is above the threshold value α (0.096 > 0.05). If the p-value is above the significance level α, H0 is accepted, showing no change in students' beginning scores between experimental and control groups. Because there is no difference in pre-test scores between the experimental and control classes, the hypothesis analysis moves on to calculate a non-parametric test on both classes' post-test results.

The Mann-Whitney test is used to see if there is a significant difference between two sets of independent data. This non-parametric test is an alternative to the parametric t-test (Harinaldi, 2005). The Mann-Whitney test yielded a p-value of 0.01. If the p-value is less than the significance level α (0.01 < 0.05), the null hypothesis (H0) is rejected. As a result, it is possible to conclude that there is a significant difference in post-test scores between the experimental and control classes, indicating that using the kitchen preparation technique for DNA isolation has an impact on students' mastery of the concept in learning about heredity substances.

The comparison of N-Gain in Figure 1 shows that in the experimental class, the majority of students fall into the medium category (70%), indicating that most students experienced a significant improvement in concept understanding after being treated with DNA isolation practice using the kitchen preparation technique. Only a small portion of students (10%) are in the high category, indicating very good concept mastery. Meanwhile, 20% of students are in the low category, indicating minimal improvement in concept understanding.

In the control class, no students achieved a high category in concept mastery. The majority of students are in the low category (60%), indicating that the teaching method used was less effective in improving students' concept understanding. Only 40% of students are in the medium category, indicating a moderate improvement in concept understanding.

The comparison of the two classes reveals that applying DNA isolation practice using the kitchen preparation approach in the experimental class had a greater impact on enhancing students' concept mastery than teaching via virtual lab videos in the control class. The experimental class has a higher number of students in the medium and high categories than the control class, demonstrating that more interactive and hands-on practical methods improve students' grasp of science subjects.

Several studies relevant to this research include Zakwandi et al. (2020), who stated that there was an improvement in students' concept mastery after participating in practical-based learning on the concept of sound intensity levels. The relatively low results pose a challenge to preparing for optimal learning in the future. Yulianti et al. (2021) showed that the application of simple, practical methods using easily obtainable and more economical materials for the topic of electrolyte and non-electrolyte solutions had a significant positive impact on students' interest in learning in Narmada District. Yuliani (2018), in her research, stated that the application of teaching materials based on simple biology practical tools in the teaching of the respiratory system affected students' interest in learning and concept mastery. This was shown by the Wilcoxon test results, which revealed that the use of teaching materials based on simple biology practical instruments had a substantial impact on students' learning interest and concept comprehension. Additionally, students' concept mastery before the learning process was categorized as poor, whereas after the learning process, it was categorized as good. The improvement in concept mastery, based on the calculation of N-Gain values, fell into the medium category.

CONCLUSION

This study evaluated the impact of using the Kitchen Preparation technique for practical activities on students' conceptual knowledge by comparing pre-test and post-test results between an experimental group and a control group. The experimental group, which performed DNA isolation using the Kitchen Preparation technique, showed significantly better improvement in conceptual understanding compared to the control group, which received traditional teaching methods. Statistical analysis confirmed the normality and homogeneity of the data, with significant differences observed in post-test results favoring the experimental group. This indicates that interactive, hands-on practical methods are more effective in enhancing students' grasp of scientific concepts than traditional teaching methods. However, this study does not investigate if similar conclusions may be obtained using other practical methodologies or whether the findings are limited to the topic of heredity. Future research should explore the effectiveness of the practical method across different topics and contexts to determine its broader applicability.

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