e-ISSN: 2986-1667
EDUCATUM
Scientific Journal of Education
https://ojs.jurnalbk.com/index.php/educatum

DEVELOPMENT OF A BIOTECHNOLOGY PRACTICUM MANUAL TO IMPROVE THE SCIENCE PROCESS SKILLS

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Abstract. *Practical activities are one part of the science learning process which requires teaching materials in the form of practical manuals that are specific to the learning material. The research objectives are to describe the development results, validity results, practicality results, and analyze the effectiveness results of the Biotechnology practicum manual to improve students' science process skills. The research method uses R&D and the ADDIE development model. The results of the research are the development of a Biotechnology practicum manual consisting of, front cover, foreword, table of contents, list of pictures, practicum rules, format and rules for writing practicum reports, procedures for using the practicum manual, competencies to be achieved, practicum topics, author profile , and back cover. The results of the product validity value of practical manuals for material experts were 98.4%, media experts were 83.75%, and practitioners were 96.92%. The practicality value of the student response test practicum manual product was 87.61%. The results of the effectiveness value of the practical manual for the experimental class were greater than those for the control class, namely 68.37 > 51.37. The results of the analysis of the Independent sample T-test, the significance value (2-tailed) is 0.000 (<0.05), meaning that there is a significant difference between the control class and the experimental class. The conclusion is that there is an influence of using the Biotechnology practical manual on the science process skills of class IX students in Kalidawir 1 Middle School.*

Keywords: *Biotechnology, Practical Manual, Science Process Skills*

Article info:

Submitted: 25, January, 2024 *Accepted: 26, Feberuary, 2024*

How to cite this article:
Nur Asykin, Haslinda Yasti Agustin, "Development of a Biotechnology Practicum Manual to Improve the Science Process Skills", *EDUCATUM: Scientific Journal of Education.* Vol. 2, No. 1, pp. 24-31, February, 2024.

1. INTRODUCTION

The learning process is a process in which there is interaction between a teacher and students to achieve learning goals. The learning process was developed to help students develop knowledge, thinking skills and psychomotor skills. The learning process requires teaching materials that have been specifically designed to help students understand a learning topic, as well as involving students to be more varied and interactive based on individual development [1].

The learning process in science subjects or natural sciences (Natural Sciences) is a component of the curriculum, science subjects contain knowledge that is systematically arranged, generally applicable (universally) in the form of a collection of observational and experimental data. Science learning is related to finding out about nature and the environment, so that science learning is not just about mastering concepts, but is based on facts and principles which become a process of discovery [2]. Science learning in its implementation is related to practicum activities which aim to emphasize providing students with experience in achieving competency, so that students can explore and understand further their environment [3]. Therefore, science learning should be designed in such a way that it becomes a fun activity. Science learning is oriented towards student activities by seeing and directly experiencing the concepts being taught. Students are expected to remember the competencies learned more easily, especially if they are connected to their daily lives, so that learning will be more meaningful and students can apply them in real life [4].

Application in science learning can be done using experimental or practicum learning methods, which can generally be done outside the classroom. For example, at the SMP/MTs education level for science subjects, there are practicum activities on Biotechnology material. In biotechnology learning, teachers often face challenges in providing examples of real products resulting from biotechnology, which are only presented in tables and pictures in textbooks without in-depth explanations of the manufacturing process. Practical activities on Biotechnology material have not been carried out effectively and maximally, because there are no specific practical manuals arranged systematically to suit students' conditions. This is an inhibiting factor in implementing practicum.

Barriers that occur in practical activities cause low practical skills in students, especially in students' science process skills which include the activities of observing, classifying, interpreting, predicting, asking questions, formulating hypotheses, planning experiments, using tools and materials, applying concepts, and communicating [5]. These science process skills are important to carry out in practicum activities, so that practicum activities have a clear direction and point of view. Through science process skills, students are expected to better understand the process or practicum activities they are carrying out, thereby involving students' active and creative thinking after carrying out practicum activities.

To be able to run science process skills effectively and optimally requires teaching materials in the form of practical manuals that are specific to the learning material. Therefore, it is very necessary to develop practicum manuals to support practicum activities on Biotechnology material. Practical manuals for Biotechnology material are not designed separately and are only included in textbooks, have not been arranged systematically and contain limited material exposure, as well as work procedures that are difficult for students to understand. Practical manuals for Biotechnology material need to be designed separately and made attractive to suit students' needs, so that in practical activities students have directed instructions and can easily understand work procedures, as well as the availability of tools and materials used according to the students' conditions.

The practical instructions available in student textbooks are not sufficient to provide opportunities for student creativity. There is a need for a specific student practicum manual, so that practicum activities have practicum instructions with clear and structured components to make it easier for students to carry out practicum [6]. The use of practicum manuals plays a very big role in the science learning process, so it seems as if this book is a magic book when a teacher is going to carry out practicum. A smooth practicum requires a practicum manual so that the practicum activities run smoothly and the practicum objectives are achieved [7].

Based on the background above, to fulfill the science learning process in Biotechnology material which aims to improve students' science process skills, it is necessary to develop teaching materials, practical manuals to support practical activities. The aim of the research is to describe the development results, validity results, practicality results, and analyze the effectiveness results of the Biotechnology practicum manual to improve students' science process skills at Kalidawir 1 Middle School.

2. RESEARCH METHODS

This type of research is Research and Development Research and Development, which aims to develop a product. The product developed is a practical manual for Biotechnology material. The development model used is the ADDIE model with 5 stages, namely analysis, design, development, implementation and evaluation. The design in this research uses the Quasi Experimental Design experimental method, with the design form being Non-equivalent Control Group Design. Research data sources were not randomly selected to be included in the experimental group and control group. This research design used two classes, where one class was an experiment that was given learning treatment using practical manual book teaching materials, and the control class used textbook teaching materials to determine the differences in the increase in students' science process skills obtained through two different types of learning methods. This research was conducted at SMPN 1 Kalidawir in class IX, taking samples in class IX A as an experimental class with a total of 30 students, and in class IX B as a control class with a total of 30 students. Data collection techniques in this research were obtained using interviews, questionnaires and observation methods. Data analysis in this study used prerequisite tests, namely, normality test and homogeneity test. Next, a hypothesis test was carried out to see tentative assumptions regarding differences in results from the two research groups. After going through the prerequisite tests, if the data is declared to be normally distributed and homogeneous, then it can proceed to statistical tests, namely the Independent Sample T-test to compare two unpaired samples.

3. RESULTS AND DISCUSSION

Results of product development for Class IX Biotechnology Practical Manual at SMPN 1 Kalidawir

A good practicum can be carried out if it is supported by components that have been prepared before the practicum takes place, one of these components is the practicum manual [8]. A practical manual is a book prepared to help carry out practical work which contains the title of the experiment, objectives, theoretical basis, tools and materials, as well as statements that lead to the objectives by following the rules of scientific writing [9].

The results of the practical manual developed consist of several parts, which are divided into the initial part (initial cover, foreword, table of contents, list of figures, practicum rules and practicum report format, procedures for using the practicum manual, and competencies to be achieved), contents (practical topics, practical objectives, theoretical basis, tools and materials, work procedures, observation tables, discussion, discussion questions, reflections and reference list), and the final part (author's biography, and back cover).

The product results of the practicum manual above are in accordance with the reference for writing teaching materials. The practicum manual contains matters related to the practicum, namely the practicum title, theoretical basis, practicum objectives, tools and materials, work procedures or steps, observation results, discussion questions, reflections, and a list of references [10].

Validity Results of Class IX Biotechnology Practical Manual at SMPN 1 Kalidawir

Product validation is carried out by 3 validators consisting of material experts, media experts, and practitioners (teachers who teach science subjects). The product that has been developed by researchers is in the form of a practical manual.

1. Material Expert Validation Results

There are six indicators for validation from material experts, namely the suitability of the title to the Biotechnology material, the content of the practicum instructions in accordance with basic competencies, the relevance of the content to topic 1 of conventional biotechnology which contains the practicum for making white sticky rice tapai, the practicum for making yoghurt, the practicum for making tempeh, the relevance of the content to the topic 2 modern biotechnology containing practical DNA isolation in fruit. There are 50 validation statements to material experts with a maximum score of 250. The total score obtained from material expert validation is 246 with a score percentage of 98.4% so that the product can be declared "Very Eligible" for testing. If the validation score percentage reaches 81% -100% then the product is declared very suitable for testing. If the validation score percentage reaches 81%-100% then the product is declared very feasible [11]. If the media feasibility test gets a percentage of 81% -100%, it means that the learning media developed is included in the very feasible category [12].

The suggestions for improvement given by material experts are:

a. In general, this practical manual has been written very well. Based on the validation process that has been carried out, this book is suitable for use, but several small details can still be improved to improve the readability of the Practical Manual.
b. Consistency in the use of terminology and sentence improvement can also be improved in several parts.

2. Media Expert Validation Results

Validation from media experts has two assessment components, namely, the practical manual component and the format for writing the practical manual. It is hoped that the validator can correct the completeness of the practical manual components by checking the "exists" or "not" columns on all book components on the instrument sheet. If all the "exist" columns on the instrument are checked, then the practicum manual has been prepared. Complete of its components.

The format for writing a practical manual contains a score column that can be assessed by the validator based on the suitability of the instrument to the practical manual. Validation from media experts on the practicum manual component assessment instrument included 13 components assessed, while in the assessment instrument for the practicum manual writing format there were 16 indicators assessed. The validation statement to media experts in the assessment of the format for writing practical manuals contained 16 assessment items and a maximum score of 80. The total score obtained from media expert validation was 67 with a score percentage of 83.75% so that the product could be declared "Very Eligible" for testing. If the validation score percentage reaches 81% -100% then the product is declared very suitable for testing. If the validation score percentage reaches 81%-100% then the product is declared very feasible. If the media feasibility test gets a percentage of 81% -100%, it means that the learning media developed is included in the very feasible category [8].

The suggestions for improvement given by media experts are:

a. Theoretical basis page for each practical topic, based on advice from expert media should add images to provide more explanation details related to practical topics.
b. Work procedure pages for each practical topic, based on advice from expert media should add image illustrations to provide explanations more details regarding work procedures.

2. Practitioner Validation Results

Practitioner validation carried out by science subject teachers contained 13 indicators assessed and a maximum score of 65. The total score obtained from practitioners was 63 with a score percentage of 96.92% so that the product could be declared "Very Eligible" for testing. If the validation score percentage reaches 81% -100% then the product is declared very suitable for testing [11]. If the validation score percentage reaches 81% -100% then the product is declared very feasible [12]. If the media feasibility test is carried out, the research gets a percentage of 81% -100%, which means the learning media developed is included in the very feasible category [13].

Practical Results of the Biotechnology Practical Instruction Book for Class IX at SMPN 1 Kalidawir

The response test was given to students at SMPN 1 Kalidawir who had taken the science subject Biotechnology material to find out the practicality of the practical manual for Biotechnology material. Testing student responses was carried out after validating several experts, namely media experts, material experts and practitioners (teachers who teach science subjects). The results of the student response test were obtained by distributing response test questionnaire sheets online via Google Form, to 72 respondents to provide practical value whether or not the Biotechnology material practicum manual product was available.

The average score obtained was 87.61% which has book meaning Biotechnology practicum instructions are very practical to use as teaching materials for practicum activities in science subjects with Biotechnology material.

Results of the Effectiveness of the Biotechnology Practical Instruction Book for Improving the Science Process Skills of Class IX Students at SMPN 1 Kalidawir

The minimum sampling used in statistical analysis measurements is 30 students [14]. Based on this opinion, a sample of 30 students from SMPN 1 Kalidawir who were taking science subjects in Biotechnology class IX A, and 30 students from class IX B, were used. Sample data was obtained from the results of the experimental class and control class observation sheet scores.

Based on the assessment of the average results, observation values the experimental class observation value is higher, namely 68.36666667, compared to the control class observation value, namely 51.36666667. The results of the observation sheet results from the experimental class and control class that were obtained

were then carried out by the Kolmogorov-Smirnov normality test using IBM SPSS 26. The criteria for testing Kolmogorov-Smirnov normality using the IBM SPSS 26 program are as follows [13]: a.

a. Data is normally distributed if the significance value shows more or equal to 0.05 (5%)
b. Data is not normally distributed if the significance value shows less than 0.05 (5%)

Based on the results of observation values from the IBM SPSS output 26 uses Kolmogorov-Smirnov normally distributed data because, the *Asymp*.Sig. (2-tailed) significance obtained is 0.200 and is greater than the significant value of 0.05. Therefore, further testing to determine whether a teaching material is effective or not can be analyzed using a homogeneity test. The homogeneity test is a test used to find out whether the two classes used in research have the same variance or not. It is said to be homogeneous if the sig value. > 0.05. On the other hand, if the sig value. < 0.05, then it is called inhomogeneous.

Based on the results of the homogeneity test analysis show a sig. 0.517, if 0.517 > 0.05 it means the data tested is homogeneous/the same. After the prerequisite tests have been fulfilled, to find out whether the product is effective or not, the Biotechnology practical manual product is followed by a T-test. The T-test technique used is the Independent Sample T-test, which is to compare two unpaired samples. If it is large (P > 0.05), it means that there is no influence of the practicum manual teaching materials on students' science process skills, while (P < 0.05) means that there is an influence of the practicum manual teaching materials on students' science process skills.

Based the calculation results show that the average comparison value for the experimental class is greater than that for the control class, namely 68.37 > 51.37. Thus, it can be concluded that the Biotechnology practical manual improves students' science process skills compared to classes that use school textbooks.

Based on the t test results show a sig value. (2-tailed) is 0.000, if 0.000 < 0.05 it means that there is a significant difference between the experimental class and the control class, so it can be concluded that there is an influence of using the Biotechnology practical manual on the science process skills of class IX students at SMPN 1 Kalidawir. This can be seen from the differences in the science process skills of experimental class and control class students.

Practical activities for making tapai in the experimental class, using the Biotechnology practicum manual in the work procedures section, it was seen that there was student activity when making tapai (students made observations during the process of making tapai, students saw the maturity time of the tapai properly, saw the difference in the texture of the tapai before and after fermentation) . Meanwhile, in the control class for the practical activity of making tapai using school textbooks, students seemed confused during the process of making tapai, so that the practicum did not run optimally, because the school textbook had limited content in the work procedures section. This influences students' science process skills on observing indicators.

Practical activities for making tapai in the experimental class, using the Biotechnology practical manual in the work procedures section, it was seen that there was student activity when grouping tapai based on the tapai containers used (jelly cups and banana leaves), in the observation table there was student activity (when grouping tapai results on the day 1st, 2nd day, 3rd day in the observation table). Meanwhile, in the control class, tapai practicum activities used school textbooks, it was seen that the students' activities only used one of the tapai containers in the form of banana leaves. This influences students' science process skills on grouping/classification indicators.

The practicum activity for making tapai in the experimental class, using the Biotechnology practicum manual in the discussion questions section, showed that there was student activity when answering the results of the discussion questions which were linked to the results of observations and theories obtained, then students presented the results to find out the differences in results with other groups. . Meanwhile, in the control class for practical tapai activities using school textbooks, it was seen that the students' activities only answered discussion questions, but did not present the results of the discussions. This influences students' science process skills on interpreting indicators.

Practical activities for making tapai in the experimental class, using the Biotechnology practicum manual in the practicum topic section, showed that there were student activities expressing possible results in the situation before being observed (students were able to predict when the white sticky rice would become tapai). Meanwhile, in the control class of practical tapai activities using school textbooks, it was seen that there were student activities that did not reveal the results that might occur in the situation before being observed. This influences students' science process skills in predicting indicators.

The practicum activity for making tapai in the experimental class, using the Biotechnology practicum manual for the rules and format of practicum reports, showed that there were students actively asking questions regarding how to make practicum reports. In the tools/materials section, students can be seen actively asking about the measurements used (what if the measurements used are more than the specified tools/materials, does it affect the maturity time of the tapai, if one of the tools used is not available, does it

affect the tapai making process). In the work procedures, students can be seen actively asking questions (if one of the work procedures is missed, will this affect the results of the tapai making practicum?). Meanwhile, in the control class that used school textbooks, it was seen that students were less active in asking questions about practical topics and discussing other things outside of practical topics. This influences students' science process skills on the indicator of asking questions.

Practical activities for making tapai in the experimental class, using the Biotechnology practicum manual in the observation results table section, showed that there were students' activities in knowing several factors in the results of making tapai which had different textures based on the level of maturity. Meanwhile, in the control class which used school textbooks, it was seen that there were activities of students who did not know the factors causing differences in tapai maturity. This influences students' science process skills on the indicator of formulating a hypothesis.

Practical activities for making tapai in the experimental class, using the Biotechnology practicum manual in the tools/materials section, showed that there were students' activities in knowing the measurements that would be used for the practicum for making tapai (for example, the amount of tapai yeast used for 1kg of white sticky rice). Meanwhile, in the control class that used school textbooks, it was seen that students were confused because the school textbooks did not contain the required number of measurements. In the work procedures, students' activities can be seen to understand in a coherent way the process of making tapai that will be carried out. Meanwhile, in the control class that used school textbooks, it was seen that students were confused about the work procedures, because the work procedures contained in the school textbooks had limited sentences that were difficult for students to understand, so the practicum did not run optimally. This influences students' science process skills in the indicator of planning experiments.

Practical activities for making tapai in the experimental class, using the Biotechnology practical manual in the tools/materials section, it can be seen that the equipment used by the students is complete (using a tea strainer, when sprinkling tapai yeast into a tray containing white sticky rice). Meanwhile, in the control class which used school textbooks, the equipment used by students was incomplete (sprinkling tapai yeast into trays containing white sticky rice using their hands directly), this could affect the amount of tapai yeast spread on white sticky rice, if the tools and materials were Used incompletely also affects work procedures during practicum activities. This influences students' science process skills on indicators of using tools/materials.

The practicum activity for making tapai in the experimental class uses the Biotechnology practicum manual for all practicum activities carried out by students. The Biotechnology practicum manual used is more systematic and makes it easier for students to carry out the practicum stages. Meanwhile, in the control class, students used school textbooks to carry out practical activities, which made students feel confused about the practical instructions contained in the school textbook because they had limited materials and stages. This influences students' science process skills on the indicators of applying concepts.

The practicum activity for making tapai in the experimental class, using the Biotechnology practicum manual in the observation table section, showed that there was student activity in writing down the complete results of the practicum. Meanwhile, in the control class which used school textbooks, it was seen that there were students who wrote incomplete practicum results. In the discussion question section, experimental class students answered the questions well and completely, according to the discussion that had been carried out with the group and then presented the results in front of the class. Meanwhile, in the control class which used school textbooks, students only answered discussion questions and did not present their results in front of the class. This influences students' science process skills on communication indicators.

The effectiveness of POGIL-based practicum instructions containing SWH to improve students' science process skills on solubility and colloid product material shows that, POGIL-based practicum instructions containing SWH on solubility and colloid product material are effective for improving students' science process skills, proven by the average results -The average value of the experimental class is 0.45, while the control class is 0.28, which states that the value of the experimental class is greater than the control class [15]. The application of science process skills in plant tissue practicum shows that, through practicum activities applying science process skills can improve learning outcomes [16].

4. CONCLUSIONS

Based on the results of research and discussion that has been carried out by researchers, it can be concluded as follows:

1. The results of research on the development of Biotechnology practicum manuals consist of components such as, front cover, preface, table of contents, list of images, practicum rules, format and rules for writing

practicum reports, procedures for using practicum manuals, competencies to be achieved, conventional biotechnology practicum topics (including practicum 1 making white sticky rice, practicum 2 making yogurt, practicum 3 making tempeh) and modern biotechnology practicum topics (including practicum making DNA isolation in fruit), author profile and back cover. 2.

2. The results of the validity of the practicum manual product based on the results of the material expert validation received a score of 98.4% which is included in the very feasible category. The results of media expert validation get a value of 83.75% which is included in the very feasible category. The results of practitioner validation received a value of 96.92% which included a very feasible category.
3. The practicality results of the practicum manual product based on the results of the student response test received a score of 87.61% which is included in the very practical category.
4. The results of the effectiveness of the practicum manual are measured through the results of the observation sheet which shows the average comparison of the experimental class scores is greater than the control class, namely 68.37> 51.37. In addition, the analysis was carried out through IBM SPSS 26 using the Independent sample T-test test obtained a significance value (2-tailed) of 0.000 (<0.05) which means, there is a significant difference between the control class and the experimental class, so it can be concluded that there is an effect of using the Biotechnology practicum manual on the science process skills of grade IX students at SMPN 1 Kalidawir.

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