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Development of Microbiology Handout as Teaching Material to Improve Science Process Skills of Health Vocational Students

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ABSTRACT
This research is a research and development of Microbiology Handout on the topic "Antibacterial Test on Bacterial Growth Inhibition" which uses natural materials, namely star fruit extract (Averrhoa carambola L.), which will be used as teaching materials in the learning process to help improve students' science process skills. The purpose of developing Microbiology Handout is to produce teaching materials that are valid, practical and effective for use in learning Microbiology subjects. Microbiology Handout development uses the ADDIE development model. Validation of Microbiology Handouts was carried out by learning media and teaching material expert validators, Microbiology material experts, and Microbiology learning practitioner expert validators. The Microbiology Handout trial was conducted through three stages of trials, namely a one-to-one trial of 3 students, a small group trial of 10 students, and a field trial of 15 students. The effectiveness of Microbiology Handout in improving students' science process skills can be seen through pretest and posttest scores analyzed using the IBM SPSS version 26 application through the One Way Ancova test. The results of research and development show the acquisition of validation scores by learning media and teaching material experts of 100%, Microbiology material experts of 94.3%, education practitioner experts of 99.64%, student response results of 91.43% and efficiency results of 0.028.

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1. INTRODUCTION

Vocational High School or SMK is one level of secondary education with the specialty of preparing graduates to be ready to work. The National Education Goals of Vocational High Schools (SMK) require graduates to have hard skills and soft skills. Soft skills are skills and life skills needed to develop the concept of emotional intelligence related to personality character, communicate, and interact socially which are important for students to master after graduation (Suardipa et al., 2021). Hard skills are the ability to master science, technology and technical skills in developing intelligence quotient (IQ) related to the field of science (Suprianto and Andi, 2017). One of the hard skills that must be mastered is practicum skills that are relevant to their chosen field of expertise. Practicum is an effective means to train and strengthen their hard skills, because practicum provides opportunities for students to understand real situations related to the theory they have learned. In addition, in practicum, students not only observe directly, but are also expected to be actively involved, understand deeply, and be responsible for the results obtained, Emda (2017) said that experiments or practicum can arouse learning motivation, encourage curiosity so that this principle will support students to find knowledge through exploration. In addition, practicum activities can also help improve science process skills (Matsna, et al., 2023).

Science process skills are skills that can be used to understand any phenomenon that occurs. These skills are needed to obtain, develop and apply concepts, principles and laws that exist in science (Rustaman, 2005). Science process skills are also an important link needed for student success in an effort to solve problems in everyday life (Darmaji, et al., 2018). Science Process Skills (KPS) include activities: observing, classifying, asking questions, formulating hypotheses, planning experiments, using tools, interpreting, predicting, drawing

conclusions, communicating, and applying concepts (Tawil and Liliasari, 2014). Microbiology is a productive subject in Health Vocational Schools and requires practicum to provide direct experience to students so that their science process skills improve. Based on the results of a student needs analysis conducted at SMK Kesehatan Bakti Indonesia Medika Jombang on 46 students, it was reported that the main obstacle found during learning is the absence of teaching materials that contain appropriate practicum instructions, thus hindering the implementation of effective practicum and having an impact on the low science process skills of students. This is reinforced by the results of students' initial tests regarding science process skills, which resulted in an av erage score of 30.5% and was included in the low category. This proves that there is still a need to empower science process skills. Efforts to improve science process skills can be supported by the development of teaching materials in the learning process equipped with practicum instructions. Teaching materials compiled in learning media must be detailed and extensive, so that the concepts received by students to support science process skills are sufficient. One of the appropriate teaching materials to achieve this is a handout, which can provide clear and detailed practicum instructions.

Handouts are learning media prepared by educators sourced from several literatures relevant to basic competencies and subject matter that can facilitate students in following the learning process (Ningtyas, et al 2014). Handouts were chosen because they are concise and specific to certain materials and are equipped with basic theory, practicum instructions, evaluation questions, and structured assignments (Hermawati et al., 2017). The development of handouts based on pure research results conducted by the researchers themselves regarding "Antibacterial Power of Starfruit Extract (Averrhoa carambola L.) against Inhibition of Staphylococcus aureus Bacterial Growth" is expected to be a solution for students in learning Microbiology subjects, especially on one of the topics, namely "Antibacterial Test on Inhibition of Bacterial Growth". The development of this handout is expected to improve the science process skills of vocational health students.

2. RESEARCH METHOD

Microbiology Handout development research aims to produce products in the form of handouts for Microbiology subjects. The development of Microbiology Handout uses the ADDIE development model. The ADDIE model consists of five stages, namely analysis, design, development, implem entation and evaluation (Rayanto Yudi Hari & Sugianti, 2020). The handout was prepared based on the results of pure research conducted by the researcher and was designed using the Canva application. The subjects of research and development are students of class XI of the Medical Laboratory Engineering Department of SMK Kesehatan Bakti Indonesia Medika Jombang with a total of 46 students, consisting of two classes, namely one control class and one experimental class. The type of research used is quasi experiment with pretest-posttest non-equivalent control group design (Leedy & Ormrod, 2015). Data collection instruments and data analysis techniques collected in the research and development of Microbiology handouts are qualitative data (criticisms and suggesti ons from 3 validators and 23 respondents) and quantitative data (assessment score results from validators and respondents and pretest-posttest results). Quantitative data analysis is explained as follows. Test the validity of teaching material experts, material experts and educational practitioners. Quantitative validation data were analyzed using the following formula.

$$V = \frac{Tse}{Tsh} \times 100$$

Source: (Akbar, 2013)

Description: V: Percentage of validity
Tse: Total score from the validation questionnaire
Tsh: Total maximum score from the validation questionnaire

The level of validity criteria of the handouts developed data from the assessment of validators and field practitioners can be seen in the percentage results in Table 1

Table 1. Criteria for Handout Validity

Validation Criteria (%)	Level of Validity
81,00% - 100%	Very valid, or can be used without improvement
61,00% - 80,00%	Moderately valid, or can be used but needs minor improvements
41,00% - 60,00%	Less valid, or recommended not to be used because it needs major improvements
21,00% - 40,00%	Invalid, cannot be used
00,00% - 20,00%	Highly invalid, cannot be used

Source: Modified from Akbar (2013)

Data from the student response questionnaires were analysed using percentage response analysis. The calculation formula used as follows.

$$Response\ percentage = \frac{Number\ of\ scores\ that\ appear}{Sum\ of\ ideal\ scores} \times 100$$

Source: (Akbar, 2013)

The criteria for the practicality of student response questionnaire data on the developed handouts are reviewed from the percentage results in Table 2.

Table 2. Handout Practicality Criteria

Validation Criteria (%)	Level of Validity
81,00% - 100%	Very valid, or can be used without improvement
61,00% - 80,00%	Moderately valid, or can be used but needs minor improvements
41,00% - 60,00%	Less valid, or recommended not to be used because it needs major improvements
21,00% - 40,00%	Invalid, cannot be used
00,00% - 20,00%	Highly invalid, cannot be used

Source: Modified from Akbar (2013)

Effectiveness Test

The effectiveness of the Microbiology handout to improve students' science process skills using pretest and posttest scores. The normality test uses the value of the Shapiro-Wilk test, and the homogeneity test uses Levene's Test of Equality of Error Variance. The effect of using microbiology handouts in the Microbiology learning process can be known from the value of the analysis results of the One Way ANCOVA Test. The analysis results were used to test the effectiveness of microbiology handouts in learning to improve students' science process skills. They were used to prove the effect of microbiology handouts on students' science process skills. Microbiology handouts can be categorised as effective or influential if the p-value <0.05.

3. RESULT AND DISCUSSION

The development of microbiology handouts uses the ADDIE model, which describes the stages.

1. Analysis

Based on the needs analysis questionnaire results, it is known that students need teaching materials that are sourced from research results and contain contextual material based on problems in everyday life. This is also reinforced by the results of the teacher needs analysis questionnaire, which obtained information that students have difficulty understanding the concept of antibacterial power activity so that it has an impact on students' science process skills on the learning sub-topic "Antibacterial Test on Inhibition of Bacterial Growth".

2. Design

The purpose of the design stage is to design handouts based on pure research conducted by researchers, about "Antibacterial Power of Starfruit Extract (*Averrhoa carambola* L.) on Inhibition of *Staphylococcus aureus* Bacterial Growth" and design learning devices. The results of pure research conducted by researchers are used as teaching resources in the form of practicum instructions equipped with original photographs from researchers so that students can have a clear picture of what to do during the practicum. In the handout, there is also a guide on how to calculate the inhibition zone produced by star fruit extract in inhibiting the growth of *Staphylococcus aureus* bacteria. This is in line with Prastuti & Naqiyah (2018) stated that teaching materials must display clear images. This aims to increase motivation, interest in learning, and the ability of students.

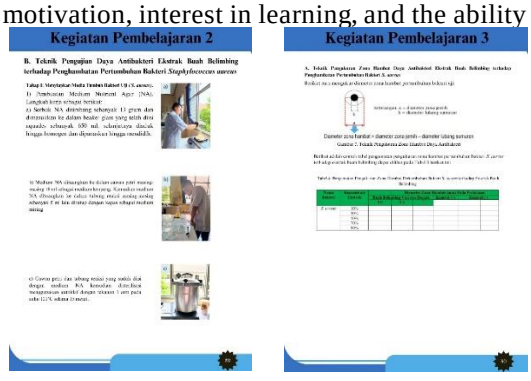

Figure 1. Visualization of Handout

3. Develop

At the development stage, the teaching material design that was previously prepared will begin to be developed. This development stage is also carried out product validation which aims to produce teaching material products that are valid, practical, and effective in the learning process. Validation was carried out by several experts, namely media and teaching material experts, Microbiology material experts, and educational practitioners. The results of the validation of Microbiology Handout by media and teaching material experts are shown in Table 3. The validity criteria by media and teaching material experts state that this handout is very valid with a percentage of 100%

Table 3. The Handout Validation Result by Media and Teaching Material Experts

No	Indicator	Average	Percentage (%)	Category
1	Content eligibility	5	100	Very Valid
2	Linguistics	5	100	Very Valid
3	Serve	5	100	Very Valid
4	Component Completeness	5	100	Very Valid
5	Graphics	5	100	Very Valid
Average Percentage validation result (%)			100	Very Valid

Source: Adapted from Depdiknas 2008, teaching material development guide

The validity test has been carried out by teaching material experts and learning devices by obtaining an average percentage of 100% validation results showing a very valid category according to Akbar (2013) after going through a revision process. Validation of Microbiology handouts by teaching material experts is important with the aim of knowing the level of feasibility of Microbiology handouts used as teaching materials in the learning process of Microbiology subjects. The results of the validation of Microbiology handouts by material experts can be seen in Table 4. Criteria for validation by Microbiology material experts are very valid with a percentage of 94.3%.

Table 4. The Microbiology Handout Validation Result by Material Experts

No.	Indicator	Average	Percentage (%)	Category
1.	Description Material with KD and IPK	4.7	93	Very valid
2.	Accuracy of the material	4.6	92	Very valid
3.	Breadth of material	4.7	93	Very valid
4.	Sophistication of the material	4.5	90	Very valid
5.	Encourage student curiosity	4.25	85	valid
6.	Presentation technique	5	100	Very valid
7.	Presentation support	4,8	96	Very valid
8.	Presentation of learning	5	100	Very valid
9.	Coherence and coherence of thought	5	100	Very valid
(Average percentage of validation results (%)			**94.3**	**Very valid**

Source: Adapted from BSNP (2014)

The validity test has been carried out by Microbiology material experts to obtain an average percentage of validation results of 94.3% which is classified in the very valid category according to Akbar (2013) after going through a revision process. Validation of Microbiology handouts by Microbiology material experts is important to do with the aim of knowing the level of feasibility of Microbiology handouts to be applied in the learning process (Nesri et al., 2020). The validity test of handouts has also been carried out by expert practitioners of Microbiology learning can be seen in Table 5. Criteria for validation by expert practitioners of Microbiology learning obtained an average percentage of validation results of 99.64% which is classified in a very valid category according to Akbar (2013).

Table 5. The Handout Results Validation by Microbiology Learning Practitioners

No.	Indicator	Average	Percentage (%)	Category
1.	Breadth of material	4,9	97,5	Very valid
2.	Clarity of material presentation	5	100	Very valid
3.	Up-to-date material	5	100	Very valid
4.	Language feasibility	5	100	Very valid
5.	Presentation technique	5	100	Very valid
6.	Presentation support	5	100	Very valid
7.	Use of handouts	5	100	Very valid
Average percentage of validation results (%)			**99,64**	**Very valid**

Source: Adapted from BSNP (2014)

Validation of Microbiology handouts by expert practitioners of Microbiology learning is important to do with the aim of knowing the level of feasibility of Microbiology handouts to be implemented in the learning process of Microbiology subjects (Setambah et al., 2017).

4. Handout Implementation in Microbiology Learning

At the implementation stage, the validated Microbiology handout is then implemented to students. The most important thing at the implementation stage is to prepare teachers and students. Student preparation includes identification and classroom observation, preparing an implementation schedule, and technical preparation needed by students during the learning process. The implementation stage is carried out directly by researchers as teachers using Microbiology handouts that have been developed and validated by experts. The learning implementation process is assisted by students and subject teachers who act as observers. Students majoring in Medical Laboratory Engineering (TLM) classes TLM 1 and TLM 2 who take Microbiology subjects. Students totaled 46 studen ts with a division of 23 TLM 1 students who applied learning using Microbiology handouts with Problem Based Learning (PBL) models and 23 TLM 2 students who applied learning without using Microbiology handouts but using PPT with Problem Based Learning (PBL) models. There is an increase in learning outcomes after the use of handouts based on pretest and posttest scores. The highest increase occurred in the experimental class with a difference of 26.08, while the control class showed an increase difference of 17.39. The average data of pretest and posttest scores of students' science process skills can be interpreted in the form of a bar chart displayed in Figure 2.

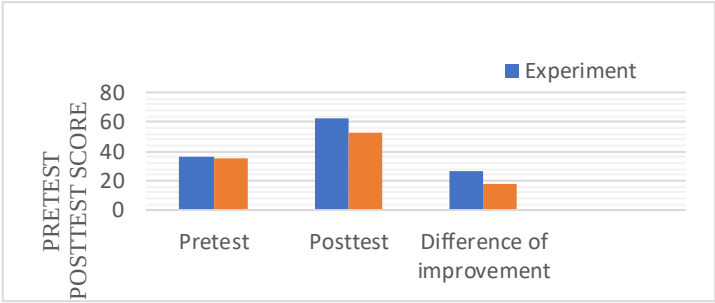

Figure 2. Mean Pretest-Posttest Score and Difference in Improvement of Science Process Skills

Practicality test results can be seen in Table 6. Practicality criteria with the results of student response questionnaires are very practical with a percentage of 91.43%. The practicality test is important to do with the aim of knowing the ease of using handouts as teaching materials by Microbiology learning practitioners and students (Annisa et al., 2020). The practicality test was also carried out through a student response questionnaire on the practicality of Microbiology handouts which contained several assessment criteria, namely: handout display design, handout components such as Basic Competencies, Competency Achievement Indicators, and learning objectives, content of learning materials, learning activities presented, and the use of handouts in the l earning process. The results of the student response questionnaire on practicality showed 91.43%.

Table 6: Practicality Test Results of Student Response

Respondents	Average (%)	Category
Student 1	92.30	Very valid
Student 2	93.07	Very valid
Student 3	93.07	Very valid
Student 4	88.46	Very valid

Student 5	93.07	Very valid
Student 6	86.15	Very valid
Student 7	90.76	Very valid
Student 8	90	Very valid
Student 9	91.53	Very valid
Student 10	87.69	Very valid
Student 11	89.23	Very valid
Student 12	91.53	Very valid
Student 13	87.69	Very valid
Student 14	90.76	Very valid
Student 15	93.07	Very valid
Student 16	93.07	Very valid
Student 17	93.07	Very valid
Student 18	93.07	Very valid
Student 19	93.07	Very valid
Student 20	93.07	Very valid
Student 21	93.07	Very valid
Student 22	93.07	Very valid
Student 23	93.07	Very valid
Average	**91.43**	**Very valid**

5. Microbiology Handout Evaluation Results

The evaluation stage was conducted after the implementation process was completed. At the evaluation stage, the effectiveness of the Microbiology handout was tested to improve science process skills. The effectiveness test of Microbiology handouts is known through pretest and posttest scores. The pretest and posttest scores were analyzed using the IBM SPSS version 26 application. To test the hypothesis, the One-Way ANCOVA test was used but before that, a prerequisite test was carried out, namely the normality test using the Shapiro-Wilk test and the homogeneity test using Levene's Test of Equality of Error Variance. The prerequisite test results can be seen in Table 7 and the hypothesis test results can be seen in Table 8.

Table 7. Prerequisite Test Results for Science Process Skills Variables

Variables	Test Type	Class	N	p	alpha	Description
Science Process Skills	Normality	Experimental class Pretest	23	0.062	0.05	Normal
	Normality	Control class Pretest	23	0.052	0.05	Normal
	Normality	Experimental class Posttest	23	0.066	0.05	Normal
	Normality	Control class Posttest	23	0.151	0.05	Normal
	Homogeneity	Pretest	44	0.849	0.05	Homogeneous
	Homogeneity	Posttest	44	0.850	0.05	Homogeneous

Table 8. Summary of Ancova Test Results for Science Process Skills

Source	Type III Sum of Squares	df	MS	F	p
Corrected Model	17591,729[a]	2	8795,864	51,174	,000
Intercept	8766,507	1	8766,507	51,003	,000
X_KPS	16539,555	1	16539,555	96,227	,000
Kelas	892,788	1	892,788	5,194	,028
Error	7390,880	43	171,881		
Total	178800,000	46			
Corrected Total	24982,609	45			

The hypothesis exmination result the One-Way ANOVA test at the 5% significance level proved that the learning procces using Microbiology handouts proved have a positive effect on students' science process skills (p-value 0.028).

6. CONCLUSION

Based on the results of research and development, it is proven that the Microbiology handout that has been developed by researchers can be concluded that the use of Microbiology Handout is effective in learning Microbiology to improve students' science process skills.

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