



THE RESULT OF SECOND FIELD TEST OF CELLULOSE DEGRADING BACTERIA FROM MANGROVE SOIL MICROBIOLOGY HANDOUT

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ARTICLE INFO

E-ISSN: 2721-0804
Vol. 2, No. 1, June 2020
URL: <http://usnsj.com/index.php/biology>

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Suggestion for the Citation and Bibliography

Citation in Text:

Nugraheni, F. S. A., Hastuti, U. S., & Rohman, F. (2020)

Bibliography: Nugraheni, F. S. A., Hastuti, U. S., & Rohman, F. (2020). The Result of Second Field Test of Cellulose Degrading Bacteria from Mangrove Soil Microbiology Handout. *Journal of Biological Science & Education*, 2 (1, June), 23-31.

Abstract

Learning media is one of the most important component in a learning process, both inside or outside a classroom. In order to provide proper learning for students based on the researcher's prior research, at least, three different field tests are needed. This research is a quasi-experiment, which is provide result of the second field test of cellulose degrading bacteria from mangrove soil microbiology handout both in cognitive and psychomotor ability. The research aims are to describe effect of this microbiology handout on student's cognitive achievement and gain data about inappropriate laboratory written instruction in this handout. Data gained by conducting learning activities using developed handout which were 2 times in class theory and three times of practical activity using instructions written in the handout. In the end of class theory activity, students did a posttest to confirm their improvement of cognitive ability while their practical ability was observed using observation sheet along with their activities. Results showed that handout which being tested could improve student cognitive at average level (n gain 0,419). In contrast, several parts of laboratory written instruction need to be fixed to make better microbiology handout.

Keywords: Average Improvement, Cognitive, Field Test, Microbiology Handout, Practical Instruction

A. Introduction

The Learning process is a planned action aimed to trigger student's reaction to a particular stimulation. It is a combination of learning and teaching activity, and also the use of learning media to enhance student's knowledge (Suaedi, 2016). There are some main components of the learning process, they are learning objective, method, media, and learning evaluation (Riyana, 2011). All of those main components will ensure the learning process quality in a learning institution.

Good learning process quality indicators are suitability among learning indicators, society's demand, student's characteristics, and learning concept; strong attractiveness; effectiveness; efficiency; and productivity (Suaedi, 2016). However, the escalation from one of those indicators in the main component will be count and valuable such as increasing the effectivity and attractiveness of learning sources.

One of way to intensify the learning process attractiveness is through learning media. The usage of learning media has widely studied and proven effectively increasing student's interest (Sulasteri et al., 2018; Sunarsih, 2019). In addition, to multiply media attractiveness, adding local learning sources as the main part of learning media is possible (Bakhtiar, 2016; Fitria et al., 2017). Learning media which contains local learning source is not only increasing it's attractiveness but also make meaningful learning or student due to student direct interaction to the material including in microbiology course.

Microbiology is one of course in several higher education study programmes, including biology education. In this course, student learn different materials in everyday's life, such as microbiology on food processing and environmental litter decomposition process (Hastuti et al., 2017). Environmental litter decomposition is a process of simplifying complex organic matters to smaller size molecules or their prime's constituents by microorganisms (Cotrufo et al., 2010). Tathis process happens in all over the world, where complex organic matters are found (Cotrufo et al., 2010).

Mangrove is one of East Kalimantan province's local learning source. In 2009, it has 364.254,989 Ha mangrove area (Badan Survei dan Pemetaan Nasional, 2009), and Margomulyo Mangrove Area in Balikpapan is one of mangrove area in East Kalimantan. It has many kinds of mangrove trees, they are *Rhizophora* sp, *Avicennia* sp, *Sonneratia casiolaris*, *Ceripos* sp, *Brugiiera Gymnorhiza*, *Lumnitzera litorea*, *Xylocarpus granatum*, *Nypafruticans*, *Acrostichum* dan *Scyphiphora* (Dinas Lingkungan Hidup Kota Balikpapan, 2016). This mangrove area is located in Balikpapan, among people's houses, so that people sometimes use mangrove's stem as housing property or open the mangrove area and change it as a residential area. These particular activities lead to stem and litter cumulation, as the result, bacteria will grow in the area. These bacteria and real-life mangrove condition will be potential learning sources for students. Studying microbiology is not only about theory but also about psychomotor skills (Hastuti et al., 2017). One of learning media which is suitable for enhancing both of this criteria is handout.

Handout as learning media has several benefits such as full of learning content but in simpler display, up to date material, and shorten delivering lecture duration (Technology, 2010). In addition, handout can be arranged as a combination among several or all of its types. In this research, researcher handout is a combination of complete note and instruction with real field study about mangrove litter bacteria. Several parts of the researcher prior publication about mangrove bacteria, and all of the pictures being shown practical laboratory activities were taken from the researcher previous suitable activities. This handout is aimed to increase student cognitive ability about environmental litter decomposition and also give them real experience about conducting laboratory activity based on their surrounding environment. Besides that, this handout developing process is based on 4D model (Thiagarajan et al., 1976) and it is already finished expert appraisal and first developmental testing.

However, before entering terminal stages and this handout can widely use in learning process, it needs to pass second (middle) field testing, and third (terminal) field testing. This paper is aimed to show the second field test result of Cellulose Degrading Bacteria from Mangrove Soil Microbiology handout.

B. Literature Review

1. Meaningful Learning

Student's prior knowledge and experiences are important factors in learning. These two factors influencing student's retention and understanding among all of the learning topics due to their knowledge will influence their new knowledge/ their ability to connect learning material to their real situation (Ausubel, 1978). Moreover, there are several essential principles about meaningful learning (Vallori, 2014), they are giving equal opportunity to all of the learners using oper work, improving learners interest in doing their task using motivation, connecting student's real-life situation to all of the learning topics, encouraging student's creativity to make their imagination and intelligence higher, linking and connecting concepts using concept mapping, and considering special needs students in the process curricula's design. Conducting meaningful learning through environmental education, students can

increase their understanding of material and also increasing their attitude and behavior towards the environment (Bager, 2008).

2. Microbiology

The word of microbiology is a common word we have heard every day. This word refers to a study about all of the microorganisms (Sattley & Madigan, 2015). There are many kinds of microorganisms, they are bacteria, archaeobacteria, protist, fungi, parasitic worms, and viruses (Maeir et al., 1982; Sattley & Madigan, 2015). Microorganisms, are not only provide awful impacts on human life but also provide various benefits to the human being. Unfortunately, there are still many children know about it poorly or even do not know about it et al (Karadon & Şahin, 2010); Ruiz-Gallardo & Paños, 2018). In contrast, microorganisms life in various places including food, soil, body, ocean, and waste (Maeir et al., 1982; Ducklow et al., 2010; Okafor, 2011; (Sattley & Madigan, 2015).

Bacteria is one kind of microorganisms, there are two groups of bacteria, they are archaeobacteria and eubacteria (Sattley & Madigan, 2015), moreover, eubacteria/bacteria is more common and has various kind of their own group. These bacteria can also live in the soil as a decomposer, such as decomposer in mangrove soil (Chen et al., 2016; Sakhia et al., 2016; Wu et al., 2016; Ambeng et al., 2019). Recent study shows that bacteria live in mangrove soil to decompose mangrove litter and constantly live at there due to condusive environment to them for living. Some example mangrove bacteria are from genus Bacillus (Sakhia et al., 2016; Ambeng et al., 2019), Micrococcus, Yangia, Rhodococcus, Escherecia, Pseudotoromonas, Aerococcus, Pseudoteromonas (Sakhia et al., 2016), Staphylococcus, Vibrio, Alteromonas, Listeria, Macroccoccus (Ambeng et al., 2019), Proteobacteria, Chloroflexi, Bacteriodetes, Planctomycetes (Wu et al., 2016). Those bacteria and mangrove soil can be potential learning sources for stundents.

3. Handout

Handout is a learning media that provides the whole topic in a simple form (Munyoro, 2014) and using as much as space on the paper (Johnson et al., 2008). The effective handout contains the following characteristics, they clarify discussion topic, increasing student concentration in class, simplify teacher explanation activities, improving the accuracy of student's note, and giving more time to do other activities in class (Technology, 2010).

However, there are several kinds of handouts including complete notes, note-taking guides, illustrations, case studies, in-class exercises, and instruction. One important thing is handout should always be simple, on purpose, and interesting for students (Technology, 2010), yet it should be updated regularly to maintain it's efficiency toward the learning process (Stacy & Cain, 2015).

C. Methodology

1. Research Design

This research was a quasi experiment research and designed as one group pretest posttest design. Students of Biology department in the 5th semester (28 students) in one of state university in Jawa were given a pretest, then they did learning activities using microbiology handout which was developed by the writer in two times class theory. After that, they did posttest. Also, after completing their theoretic class, they did practical work based on instruction in the microbiology handout. All of the development processes and errors were observed and noted in the observation sheets.

2. Instruments

There were two instruments in this research, they are cognitive and psychomotor instruments. Cognitive instrument was a set of pretest and posttest questions, moreover psychomotor instrument was observation sheets contained keyword of student's requirements, and comment section. Cognitive indicators are shown in table 1 below.

Table 1. Cognitive Indicators in Evaluation Questions

Topic	Specific Content	Bloom's Taxonomy Level
Mangrove's Ecosystem	Mangrove's soil characteristic	C2
Bacteria in Mangrove Soil	Mangrove's soil as bacteria's habitat	C3
	Mangrove's soil bacteria characteristic	C3
Method Bacteria characteristic of mangrove's soil	Bacteria in mangrove's soil as litter degrading agent	C3
	Theoretical method of isolating bacteria	C3
Cellulose Hydrolysis Index	Making a conclusion based on morphological data	C4
	Making a conclusion based on cytological data	C4
Pollution in Mangrove's Soil	Understanding theoretical method of counting cellulose hydrolysis index	C2
	Concluding the best agent of cellulose hydrolysis index	C4
Developing a Project	Understanding the effect of pollution to mangrove's soil bacteria and mangrove's ecosystem	C2
	Making a project plan based on prior knowledge about the subject	C6

Meanwhile, psychomotor indicators are shown in table 2 below.

Table 2. Psychomotor Indicators in Handout's Laboratory Activity

Stage	Indicator
Preparation	Preparing proper tools for activities
Conducting activities	Using proper personal protective equipment
	Placed all of the tools in a logical sequence
	Using all of the tools in safe way
	Using all of tools in efficient way
	Doing all of the laboratory activities based on written instruction in the handout, including: <ol style="list-style-type: none"> a. Preparing growth media for bacteria b. Isolating cellulose degrading bacteria c. Counting Cellulose Hydrolysis Index (CHI)
Making a conclusion based on result of activities	Making an appropriate conclusion about the highest and lowest CHI among all of the isolated bacteria.

3. Technique of Data Analysis

a. The cognitive instrument was analyzed based on the following ways

Pretest and posttest were analyzed using n-gain (Hake, 1999), which aimed to know student's cognitive ability improvement during using microbiology handout. The formula is:

$$N\text{-gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}}$$

Furthermore, the result of that calculation compared by following criterion:

Table 3. Gain Criterion

N-gain score	Criterion
0,00 < n-gain < 0,30	Low
0,30 < n-gain < 0,70	Average
n-gain > 0,70	High

(Source: Hake, 1999)

b. The result of psychomotor observation was analyzed using descriptive-analytic way to gain more information about handout psychomotor instruction weakness. This weakness will

lead to a revision process to enhance student's better understanding of using this handout as cellulose degrading bacteria isolation and it's cellulolytic index laboratory activity guidance.

D. Findings and Discussion

1. Findings

These are findings in this research:

a. Student Cognitive Ability

Student's cognitive scores are shown in table 4.

Table 4. Student's Pretest and Posttest Scores

Scores	Pretest (Amount of Students)	Posttest (Amount of Students)
42-60	14	3
61-79	11	11
80-98	3	14

Furthermore, scores above were analyzed using n-gain as mention in the method and the result can be found in table 5.

Table 5. n-Gain Calculation

Pretest Score Average	Posttest Score Average	Maximum Score	n-Gain	Criterion
63,243	77,804	98	0,419	Average

Based on data in table 4, numbers of student in the first group (the lowest score) was decreased from 14 students in pretest to only 3 students in posttest, moreover, the third group (the highest score) were increased drastically from only 3 students in pretest to 14 students in the posttest. This finding suggests that this handout gives impact to student's score. This is also supported with n gain data (0,419) in table 5.

b. Student Psychomotor Ability

Laboratory activities using developed handout were conducted in 3 meetings. The first meeting was preparing growth media for bacteria, the second meeting was isolating cellulose degrading bacteria and the third meeting was counting Cellulose Hydrolysis Index. The class was divided into 7 different groups and each group consists of 4 students. During the observation, students were done several mistakes. Observation result on activity shows that there were several problems as shown in table 6.

Table 6. Result of Psychomotor Ability of Student While Using Handout as Laboratory Activities

Instruction			
Indicator	Amount of Mistaken Group	Possible Cause	Follow Up in Handout Development Stage
Preparing proper tools for activities	-	All of the needed equipment is shown and mentioned in the first page of every topic in every laboratory activity.	-
Using proper personal protective equipment	1 group	Students do not understand how useful personal protective equipment is or feel it is necessary.	Making "warning" on the first page of every laboratory activity written in handout about using proper personal protective equipment before starting an activity.

Placed all of th tools in a logical sequence	3 groups	Students do not read the handout carefully and do not understand how to organize proper tools at appropriate places.	Replace the tools picture with appropriate arrangement.
Using all of the tools in a safe way	3 groups	Many students try to interrupt their friend's jobs due to curiosity.	-
Using all of the tools in efficient way	6 groups	Many student's do not understand how to use the basic measurement tool	Put a link in the handout about how to use measurement and all needed tools in the handout.
Doing all of the laboratory activities based on written instruction in the handout, including:			
a. Preparing growth media for bacteria	3 groups	Students do not familiar with bacteria's media compositions so that some groups did not mix the composition properly	Make a little explanation about unfamiliar composition and how to mix it properly before entering instruction.
b. Isolating cellulose degrading bacteria	3 groups	Some of the student's groups did not read the written instruction carefully and felt confused about how to isolate bacteria from soil mixture.	-
c. Counting Cellulose Hydrolysis Index (CHI)	7 groups	Students do not know how to measure CHI due to a lack of understanding of how to use basic measurement tools.	The same as "using all of the tools in efficient way's" follow up.
Concluding the highest and lowest CHI among all of the isolated bacteria.	-	Clearly shown by the CHI data.	-

2. Discussion

Developing learning media is one essential thing of teacher activity to make the learning process more interesting and efficient. This is due to learning media's role as learning source and message delivery agent (Asnawir et al., 2016). There are many models of learning media development but teachers can always choose one of their preferences. Generally, there are 3 stages of learning media development. They are the initial stage (understanding the problem), arranging stage (making the learning media), and dissemination stage. Before a learning media is ready to implement in a wide population, many stages needed to confirm it's effect on student's achievement. Those stages are expert validation, first field test (student response), second field test, and third field test. Every stage should gain positive results before entering the next test.

As mentioned before, this microbiology handout already passed expert validation and first field test, and this research focuses on second field test or also known as the middle field test.

The result from this second field test will be an important suggestion to the next stage of the development process, both in cognitive and psychomotor components in handout.

The cognitive posttest result after using this handout was shown positive outcomes, as shown in table 4, there were drastic alterations of students score in lowest and highest groups, in contrast, the amount of students in the middle group was still in the same. From this score, we can see that cellulolytic microbiology handout gives alteration to student's cognitive scores in environmental microbiologi especially in mangrove soil degrading bacteria. This data is also confirmed by n-gain calculation result as shown in table 5 (0, 419).

The increasing cognitive score in this topic can be caused by A several factors such as students learned from the systematic handout, and then they connected it to the prior knowledge (Ausubel, 1978). This is possible because of microbiology handout was systematically organized. Good handout can lead to better understanding due to its function as a material provider and a learning topic's clarifier (Technology, 2010; Nelson-Wong et al., 2013; Munyoro, 2014; Wongkietkachorn et al., 2014).

Another reason is their alter motivation during the learning process. Developing learning media as a may improve student's motivation through method/process (Kaylene & Caroline, 2011). This increasing motivation increases the student's learning achievement. Student's intrinsic motivation enhances their interest to learn about something (Bakar, 2014; Andrini et al., 2017; Riswanto & Aryani, 2017; Tokan & Imakulata, 2019), in this case, learn about mangrove soil cellulose degrading bacteria.

However, differ from the cognitive test results, there were still many things to repair in psychomotor instruction in this microbiology handout. As shown in table 6, the error student group's behaviour almost always be found in every indicator. This finding suggests that many improvements are needed.

According to result in table 6, the first error that should be highlighted in the handout is using proper personal safety equipment. There was one group did not use proper safety equipment during accomplishing laboratory activities. This behavior may due to their perception of safety in the laboratory. They knew about safety in a laboratory but did not take it seriously in real-life practice (Al-Zyoued et al., 2019)

The second error is misunderstanding about equipment placement in workbench. Students tend to put every equipment randomly so that it was hard for students to get their equipment as soon as they need it. This chaos happened due to unclear picture in the handout. The picture, itself, is not a perfect way to deliver some informations, that because teacher/lecturer has to make sure that picture which is being shown in the learning media is properly prepared (not making new misunderstanding to students) (Asnawir et al., 2016).

Badly using basic measurement tools is the third error. This error due to unfamiliar tool which was being used (using screw micrometer in microbiology was considered as rare) and also the last error was the step on preparing growth media for bacteria. Error in making bacteria growth media was also caused by unfamiliar ingredients of bacteria growth media. These two errors can be avoided by providing a link for students to read about it before starting the class.

However, there are two important considerations about this research, first, about the participants in this second field test were not from surrounding mangrove area/ they came from varied backgrounds so that not all of them come from or even heard about mangrove area. This factor may give different results to the microbiology handout if all of the participants come from at least, understand about mangrove area soil. The second consideration is class design in this research is one group pretest and posttest design. This design is considered as the weakest quasi-experiment design (Morgan et al., 2000). Many improvements especially in instructional laboratory activity have to be done before entering the third field test of cellulose degrading bacteria from mangrove soil microbiology handout.

E. Conclusion

According to the research result, cellulose degrading bacteria from mangrove soil microbiology handout can increase student cognitive ability in average category (n-gain 0,419), in contrast still need many improvements especially in instruction and the usage of needed tools.

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