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Developing a biotechnology practicum guidebook for producing nata de coco to increase students' learning outcomes

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ABSTRACT

This study aims to produce a product in the form of a practical work guidebook for making nata de coco to help smooth the practical work process, which was adapted from the development of a 4-D model. The 4-D model consists of 4 stages, namely the stage of defining, designing, developing and disseminating. The level of feasibility of the practical work guidebook is carried out through a validation process by material experts, media experts and supported by responses from teachers and students. The results of the validation carried out by material expert validators and media experts were categorized as "Very Eligible" with 95% and 92.85% respectively. Meanwhile, the teacher's response and the student's response were also categorized as "Good" with 95% and 99% respectively. This is supported by the effectiveness test conducted in the cognitive (pretest and posttest) and psychomotor domains. In the cognitive domain, it shows a fairly good score, which has a difference between the initial ability (pretest) and the final ability (posttest) with an average value of 46.32 to 78.12. The t test also shows a significant value of 0.000 with the "medium" N-Gain category (60.6%). The psychomotor domain also produced a score with an average of 82 of the overall score or the "Excellent" category. Based on the research data, it can be interpreted that the book developed has a considerable influence on practical learning outcomes and can facilitate students to learn, both with educators and independently in making nata de coco which is packaged in an attractive and easy to understand manner.

Keywords: Biotechnology, development, nata de coco, practical work guidebook

INTRODUCTION

The implementation of experiments in the world of education is often referred to as practical learning. Practicum is an alternative in learning that is carried out outside the classroom such as a laboratory or field. This activity can provide experience, be it a direct experience of designing an experiment with a particular object so as to increase the success of learning (Hasmiati, 2017). According to Agustina (2015) practicum activities can direct students to learn from concrete experiences so they can get new ideas and concepts. Practicum activities can train students in solving problems from theory to more real problems (cognitive) using instruments (psychomotor) (Susantini et al., 2012). During practicum activities can be done in groups or independently which will produce a product. Therefore, facilities are needed to make it easier to carry out these activities, namely by having a practicum guidebook (Nengsi, 2016).

The practicum guidebook can certainly make it easier to master the concepts to be found (Fajarianingtyas, 2020). The manual is a very important component because with the practicum manual as a reference for students which contains a series of materials and work procedures (Nikmah, 2015). Practicum guidebooks can help in student completeness and provide learning to be more varied, which makes students work with knowledge (Zulaiha et al., 2014). The ideal guidebook does not only contain tools, materials and the manufacturing process, but also contains theories or facts related to the practicum you want to carry out so that it can strengthen existing concepts.

The results of a survey conducted at PAB 8 Saentis Private High School found that practicum activities had been implemented but the manuals used by the students were still less attractive and interactive. This is because students still use guidebooks which only contain minimal work procedures without being supported by interesting pictures and complete theories so that they are less able to explore interests and curiosity for students. Thus, the biology practicum activities at the school are still not running effectively which will affect student learning outcomes.

According to Koretsky (2015) practicum activities can provide a very large role, especially in building concepts, verification (with proof), correctness of concepts, cultivating skills in the process (basic skills of scientific work and affective abilities of students) and can foster a sense of liking for lessons.

One of the sciences in biology that produces products is biotechnology. The term from biotechnology is used to produce a product from raw materials with the help of living organisms (Sutarno, 2016). Biotechnology is a material that is quite complex because it studies detailed processes, starting from procedures that must be considered to produce good products.

The results of biotechnology products are well known among the public, such as Nata de coco, but in reality there are still many who do not know about the manufacturing process.. This includes students from the private SMA PAB 8 Saentis. Students of PAB 8 Saentis Private High School experienced problems in making nata de coco due to inadequate practicum guidebook facilities and it was difficult for these students to understand. The guide used is only packaged in sheet form without supporting pictures and colors, besides that there are also several procedures that are not included as in the process of making natural starters. So that these activities are difficult to realize. In fact, when viewed from the interest of many students who are curious about making nata de coco.

Therefore it is necessary to do research in the form of developing a practicum manual to improve student learning outcomes in Biotechnology material, especially the making of Nata de coco which of course has language that is easy to understand and is also packaged in an attractive manner and has a much clearer sequence of contents like in books in circulation previously did not have instructions for using books, theoretical basis and things that need attention. The developed book already has these things, and the procedure section explains more about each process, such as making a natural starter.

METHOD

This research was conducted at PAB 8 Saentis Private High School in Medan, North Sumatra, from February to June 2022. The samples taken from this study were among 36 students from a total population of 143 students. This research is a developmental research. The development model used is the 4D model. This 4D model consists of 4 stages, namely the define, design, develop and disseminate stages.

To test the feasibility of the practicum manual, an assessment was carried out for each of 2 validators, material experts and media experts and also supported by responses from biology teachers and students. Material expert validation here aims to evaluate the handbook being developed whether it is appropriate to the material in question (Humairo, 2013) And selected lecturers or teachers who certainly master in the field of biotechnology. This is of course the same as the media expert validator who is of course selected to evaluate whether the structure of the manual being developed is sufficiently interesting (Humairo, 2013). Usually, the assessment is reviewed based on aspects of color selection, images, layout and taste of each component used in the book being developed.

The validators selected in this study were 2 people each. For the first media experts was a senior teacher teaching at SMK Negeri 5 Medan. She is a computer teacher who certainly understands design and is used in designing a book, therefore he is an expert to become a media

expert in this research. The second media expert validator was an operator and editor at SD Negeri 060935 Medan Johor. He is quite reliable in making web programmers and editing learning media at the school so that experts become experts in this research media.

The validator of material experts was also carried out by 2 people, the first validator was a biology lecturer at the Medan State University who is quite knowledgeable in the field of making natural starters in nata de coco such as conducting research in the field of bacteria "Analysis of Students' Concept Understanding of Archaebacteria and Eubacteria Material" so that he is quite expert in understanding how to make natural starters needed in Nata de coco. The second material expert validator was a biology lecturer at the Medan State University and has taught Biotechnology courses at the Bachelor level. In addition, he has conducted research on "Analysis of Students' Learning Difficulties on Biotechnology Materials in State Senior High Schools in Rokan Hilir Regency" and "Analysis of Students' Comprehension and Learning Difficulties on Biotechnology Materials Based on Class IX Indicators of Middle Schools in Padang Sidempuan City". So that way he is quite an expert in the field of biotechnology and can be used as a validator.

In this study, an effective test was also carried out to measure whether the books that had been developed could improve learning outcomes or in terms of pretest and posttest scores and supported by psychomotor scores. This research was conducted at PAB 8 Saentis Private High School in Medan, North Sumatra, from February to June 2022. The samples taken from this study were among 36 students from a total population of 143 students. This research is a developmental research. The development model used is the 4D model. This 4D model consists of 4 stages, namely the define, design, develop and disseminate stages.

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Research instruments

This study uses descriptive quantitative research, where there is involvement of a questionnaire accompanied by an explanation as a description to support the resulting data. The instruments used were pretest and posttest as well as psychomotor assessment and questionnaire distribution. The questionnaires used were: (1) expert validation sheets, both material experts and media experts, (2) questionnaires for the responses of teachers in the field of biology studies, (3) questionnaires for students' responses to the practicum manual product.

Data analysis technique

On the expert validation sheet and teacher response sheet, experts and teachers are asked to fill out an assessment of each statement, with the following score conditions: score 4 (very feasible), score 3 (decent), score 2 (less feasible), score 1 (not feasible). The eligibility criteria taken in this assessment use a Likert Scale (Table 1 and Table 2). While the student response questionnaire uses assessment criteria according to the Guttman Scale (Table 3), namely with a score of 1 for the answer "Yes" and a score of 0 for the answer "No". Then the results of validation sheets from experts, teacher response sheets and student response sheets were analyzed descriptively quantitatively using percentage techniques. The results of these percentages are then interpreted with the provisions of the criteria that have been calculated according to the number of existing statements.

Table 1. Expert validation questionnaire criteria

Score	Percentage Intervals	Validator Criteria
12 ≤ x ≤ 21	25% ≤ x ≤ 43,75%	Not Feasible
21 ≤ x ≤ 30	43,75% ≤ x ≤ 43,75%	Less Feasible
30 ≤ x ≤ 39	62,5% ≤ x ≤ 81,25%	Feasible
39 ≤ x ≤ 48	81,25% ≤ x ≤ 100%	Very Feasible

Table 2. Teacher response questionnaire criteria

Score	Percentage Intervals	Validator Criteria
17 ≤ x ≤ 30	25% ≤ x ≤ 43,75%	Not Feasible
30 ≤ x ≤ 43	43,75% ≤ x ≤ 43,75%	Less Feasible
43 ≤ x ≤ 56	62,5% ≤ x ≤ 81,25%	Feasible
56 ≤ x ≤ 69	81,25% ≤ x ≤ 100%	Very Feasible

Table 3. Student response questionnaire criteria

Score	Percentage Intervals	Validator Criteria
0 ≤ x ≤ 6	0% ≤ x ≤ 50%	Not Good
6 ≤ x ≤ 11	50% ≤ x ≤ 100%	Good

RESULTS AND DISCUSSION

The development of the practicum guidebook that has been carried out using the 4-D model consists of 4 stages, namely the define, design, develop and disseminate stages. The sample used was class XII students of senior high school. This model was chosen because in this model it has stages arranged programmatically, with systematic sequences of activities in an effort to solve learning problems that are adapted to student needs and student characteristics, besides that this method does not require a long time to process (Amali, 2019).

Define

At this stage it contains three scopes, namely: needs analysis, concept analysis and analysis of learning objectives. In the needs analysis, the needs of teachers and students at PAB 8 Saentis Private High School will be analyzed which are useful in supporting learning. Based on the observations made, there are problems encountered in the smooth running of practicum activities such as the unavailability of an interactive biology practicum manual so that both students and teachers will experience difficulties when carrying out practicum activities. The available books are still very simple or in other words are not packaged with attractive designs and graphics making it difficult to attract interest

for students. So in that way it can be said that students and teachers need guidebooks that are more interactive, have an attractive appearance, contain theories or facts that support activities, have a structured layout starting from preparation, implementation to evaluation and of course have instructions that are easy to understand and done.

Practicum learning activities can be carried out well, namely to produce the desired product, of course it must be supported by the existence of a practicum guidebook which is packaged in an attractive and certainly easy way so that learning activities not only improve learning outcomes but also train the skills of each student process (Gunada et al., 2017).

After getting what is needed, a concept analysis will be carried out. Concept analysis is carried out to outline what needs to be included in the manual that will be developed so that it can produce a product that is more attractive than the previous product. The concept that will be applied in this practicum guidebook focuses on making nata de coco by including a clear and easy-to-understand systematic way of making nata de coco and is supported by related theories and of course in accordance with the facts. The way in presenting the practicum manual is carried out systematically according to the needs of the students.

In the analysis of learning objectives is done to limit the extent to which the development of the guidebook will be carried out, besides that it is also a signpost so that in carrying out development it does not deviate from the initial goal when writing learning materials. Explanations can be seen in Table 4.

Table 4. Defining stage

	Analysis Object	Analysis Source	Synthesis
Needs Analysis	Biology students and teachers in private high schools PAB 8 Saentis	PAB 8 Saentis Private High School	Teachers and students need guidebooks that are interactive and of course also contain the demands of both language and clear procedures.
Concept Analysis	Biology teacher at PAB 8 Saentis Private High School	Lesson plan and syllabus	The book being developed refers to KD 4.10 namely "Designing and conducting experiments in the application of conventional biotechnology principles such as nata de coco"
Analysis of Learning Objectives	Biology teacher at PAB 8 Saentis Private High School	Lesson plan	The developed book aims to find out the process of making nata de coco using natural starter from pineapple

Design

The design stage aims to find out how to design a practicum manual. At this stage it consists of several stages such as selecting the material, selecting formats, concluding components in the presentation of practicum guides, and the initial design of the book.

The material selection is carried out to identify the main material that needs to be taught, collect and select relevant material and arrange it systematically. In selecting this material, of course, it must be adjusted to the characteristic needs of the target user (Kurniawan & Dewi, 2017). Selection of material must be based on facts that can be taken from various sources such as articles and books. The material contained in the practicum manual starts from the scope of conventional biotechnology, the history of Nata de coco, the meaning of nata de coco, the benefits of Nata de coco, and the systematics of making Nata de coco. The material must be packaged in sentences that only have one single meaning in each sentence, short and simple (Lestari et al., 2018). Therefore, this book is packaged using sentences that are often used and minimized with the use of foreign languages. The components in the developed book are arranged systematically, this will certainly support students in developing

critical thinking skills and empowering student arguments (Ulfa et al., 2018).

After obtaining the main material that will be presented in the practicum guide, then selecting the format is carried out. The choice of format is the selection of the selected design so as to produce an attractive product for students. This design format covers the type of paper, font type, font size, layout of each component, and the choice of color design to be used (Kurniawan & Dewi, 2017). The type of paper chosen in the development of the practicum manual is A5 (14.8 x 21 cm). For large titles, select the font type "Berlin Sans FB Demi" with size 22. As for the dominant content, use the font "Cambria" with size 14 and for the book cover use two fonts "Script MT Bold" with size 37 and "Arial Rounded MT Bold" size 15. An attractively designed guidebook can certainly increase student learning motivation starting from self-confidence, attention, relevance and satisfaction (Ariska & Ramadhan, 2015).

Determining the presentation components that will be included in the practicum guidebook will also affect the appearance of the book. If selected components that are not sustainable and not systematic will certainly cause new problems. The presentation of these components determines the harmony of the book, in the sense that the arrangement of the developed book components becomes more coherent and complete. In determining the components of course adjusted to the material to be presented. The components presented in this manual include preface, table of contents, instructions for using teachers and students, rules for implementing practicums, practicum obligations, core competencies (KI), basic competencies (KD), learning indicators, practicum objectives, basic theory, tools and materials used, experimental systematics, things that need to be considered in carrying out practicum, evaluation and bibliography. After this stage is completed, an initial draft of the practicum guidebook will be formed. The initial draft of the book can be seen in Figures 1 and 2.

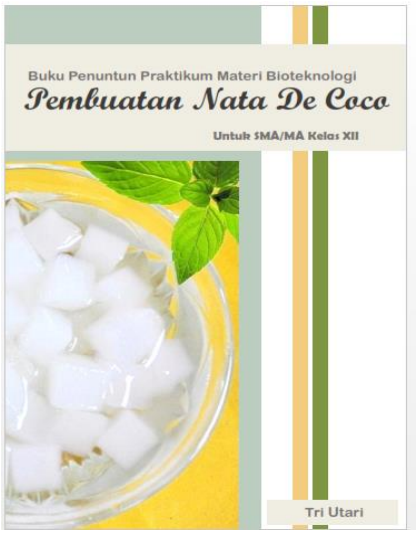


Figure 1. Display of the book cover.

The choice of color to be used in the cover has its own meaning. The yellow color mixed with green will give a light, soft, fresh impression and give a pleasant impression so that it is believed to give a distinct impression to attract the attention of book users or readers. (Purbasari et al., 2014).

Figure 2. Display of Book Contents

Choosing gray and combining it with green will give a luxurious and elegant impression. This color also gives a comfortable impression and is good enough to be used in teaching materials (Purbasari et al., 2014).

Based on the perspective of psychology, the light blue color used in this module can help calm the mind and increase concentration in learning.

The color green creates a sense of calm, fresh, and emotional balanced. Although the green color does not dominate this module, its presence

balances the other colors. The color yellow means optimism, enthusiasm and joy. Yellow is very well used to help logical and analytical reasoning, encouraging creative and original ideas (Andayani, 2017).

The choice of color in designing a product as a whole will support the success of its use. Choosing a good color will invite a positive response from its users while at the same time being amazed at the beauty of the chosen design (Sigit, 2010).

Develop

At this stage it contains the results of each response and assessment, both media expert validators, material expert validators, teacher responses and student responses. Comments and suggestions from each validator will later be used as a basis for improving it to be even better and make students more interested (Imaniarta, 2013).

The validator for each expert is chosen according to their respective field of expertise. In the material expert validator, two lecturers were selected who understand Biotechnology and the development of teaching materials. And for the media expert validator, two people with expertise in designing were also selected. Based on the results of the assessment that has been carried out by the validator of material experts and media experts, it produces a very good assessment, which is included in the "very eligible" category with an assessment percentage of 95.5% (material experts) and 92.85% (media experts) in accordance with the index has been calculated using the formula Sugiyono (2012).

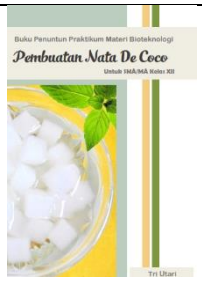
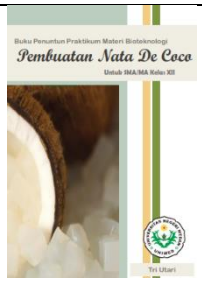
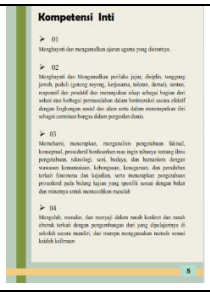
This is also supported by the results of the responses of teachers and students who gave good ratings. In the teacher's response, it has a category of "very eligible" with a percentage of 95%, which is also analyzed using the formula from Sugiyono (2012). Meanwhile, the students' responses produced the "Good" category with a percentage of 99%. This means that the developed book is easy for students to use, so it can be said to be ideal for use. According to opinion Ulfa et al. (2018), which states that an idea or good practicum guide will be a guide that is easy for students to understand so they won't be confused about what to do. The data can be seen in Table 5.

Table 5. Calculation results of eligibility for books.

Response	Average value (%)	Category
Material Expert Validation	95	Very Feasible
Media Expert Validation	92,85	Very Feasible
Biology Teacher	95	Very Feasible
Learners	99	Good

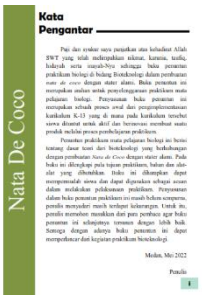
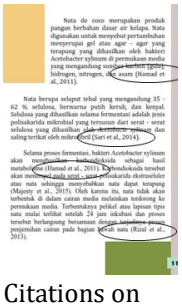
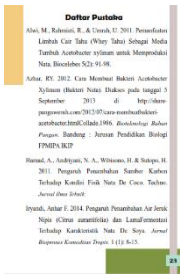
According to Purnamasari & Sukartikanti (2016) this test is carried out to find out how much practicum procedures are capable of being carried out by students, of course, in accordance with the work steps listed, so that each work step is quite easy to do or understand by students. In each test, both from the media validator and the material, there are several aspects that need to be improved so that the book being developed becomes even better. Improvements from the media expert validator can be seen in Table 6 and improvements from the material expert validator in Table 7.

Table 6. Improvement results according to media experts.

Media Expert Advice and Input		
Aspects	**Before**	**After**
Cover View		
Layout on KI		

A less attractive display on page 14		

Table 7. Improvement results according to material experts.

Suggestions and Input Material Experts		
Aspects	**Before**	**After**
Foreword		
	The appearance of the preface has unequal spacing and the word "I" is replaced with "author"	The spacing is the same and the word "I" has changed to "author".
Quoting et al and et al		
	Citations on et.al are not italicized	Italicized quote
Additional work procedures	Not yet included how to reproduce the starter before use	
		It has been included how to reproduce the starter before it is used for the next stage.
Bibliography writing		
	Improper spacing	Setting the spacing that has been set according to the SOP

Basically, guides that have good quality are guides that are easy for students to understand so that the process of practicum activities runs smoothly. In addition, the guide must also be able to position it as a source of reading to enrich insight (Sunantri, 2016).

The guide must be preceded by a theoretical basis so that it can actively lead users and provide general knowledge (Parmin, 2009). Of course, this has been included in the guide that has been developed, there is a theoretical basis which is packaged briefly and contains facts which are certainly reliable.

Disseminate

This stage is carried out by using the product that has been developed to be tested in order to determine the effectiveness of the product. This test was carried out to find out how far the practitioner can use the developed book (Imaniarta, 2013). At this stage, several tests of the test instruments used were first carried out before conducting the trial. Before the questions are used as a test measure, several tests are carried out, such as validity tests, difficulty level tests, differentiating power tests, and reliability tests. Of each of each test has its own purpose as in testing the validity of the test to measure or interpretation of each item. The difficulty level test aims to see whether the test used is included in the easy, medium or difficult category. The

discriminating power test was carried out to find out whether the questions tested had the

ability to discriminate between students who already understood the material and students who did not understand. And finally the reliability test aims to find out whether the questions used can provide consistent results or not, in other words can be trusted and reliable or not (Amanda, 2019).

The data processed to find out each of these tests was obtained from testing the test instrument with students outside the sample who had the same characteristics. Each test is carried out using Microsoft Excel 2010 because the analysis of multiplechoice questions Using Microsoft Office Excel 2010 has an appropriate design and is easy for teachers to use to analyze multiple choice questions (Pramana, 2014). Of the 25 multiple choice questions after going through several tests, only 15 were found to have a good category in every aspect.

In testing the effectiveness of the guidebook that has been developed, it is obtained from the value of sample trials in 2 domains, namely the cognitive domain by conducting initial ability tests (pretest) and final ability tests (posttest) and the psychomotor domain, namely by observing students directly in using the book. Judging from the results of the cognitive domain, the value of the pretest was carried out to get an average score of 46.32 overall. And in the final ability test is given an average score of 78.12. Of course, if you look at this, there seems to be a significant difference. But to find out the significant differences from the products we produce, a t test will be carried out. The t test is a test in parametric statistics which aims to compare or compare in other words to see if there is a difference from one aspect to another (Mustafidah, 2020).

Before doing the t test, the homogeneity test and normality test are first carried out. Homogeneity test was carried out to find out whether the two sample data that have been obtained come from populations that have the same variance with the terms Sig > 0.05 (Saragih, 2015). While the normality test is to find out whether the resulting data has a normal distribution with the condition that Sig > 0.05. Both tests are calculated using SPSS version 22 because the features in it are more supportive and make it easier to work on.

Based on the results of the tests carried out through the pretest and posttest values, the data is normal and homogeneous. Based on the results of normality calculations, it shows that the pretest significance value is 0.062 (sigh > 0.05) and the posttest value also shows a value of 0.182 (Sig > 0,05). Therefore, it can be concluded that the pretest and posttest values are normally distributed. This can be seen in Table 8.

Table 8. Normality test calculation results tests of normality.

	Kolmogorov-Smirnov[a]		
	Statistic	**Df**	**Sig.**
Pretest	.169	25	.062
Posttest	.146	25	.182

In the homogeneity test it was found that the results of the calculation of the pretest and posttest data had homogeneous data variants because the value shown was more than 0.05, namely with a value of 0.381 according to Saragih's (2015) opinion. This homogeneity test was analyzed using SPSS software version 22 (Table 9).

Table 9. Homogeneity test results.

Levene Statistic	**df1**	**df2**	**Sig.**
1.125	5	19	.381

From the results of the t test, a significance value of 0.000 is obtained, which means 0.000 ≤ 0.05, so it can be concluded that there is a significant difference between the pretest and posttest values. This is in accordance with the opinion of Saragih (2015) which states that if the resulting value of the t test shows <0.05 it can be said that there is a difference between the two data tested (pretest and posttest) and vice versa. This can be seen in Table 10 sample statistics, Table 11 Samples Correlations and for the t test in Table 12.

If there is a significant difference between the pre-test and post-test scores, then the N-Gain score is calculated to obtain the effectiveness of

increasing the value taken from the students using the nate de coco practicum manual. The results of N-Gain calculations use Microsoft Excel 2010. The N-Gain value obtained is around 0.606 if accumulated in the form of a percentage which is 60.6% and is included in the "Medium" category according to the category proposed by Archambault (2008).

Table 10. Results of samples statistics.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	46.3200	25	10.34295	2.06859
	Posttest	78.1200	25	11.22616	2.24523

Table 11. Results of sample correlations paired samples correlations.

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	25	.744	.000

Table 12. Test results of t.

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest Posttest	-31.80000	7.76745	1.55349	-35.00625	-28.59375	-20.470	24	.000

In the psychometric domain, students are directly assessed when they use the book. This psychomotor analysis refers to the students' skills in realizing the developed book. This can be seen from how students carry out practical learning using the developed book. This assessment was filled directly by the teacher and also fellow researchers. The results of the psychomotor assessment obtained an average score of 82 with an individual score range of 73-100. If seen from the criteria table, it can be said that the results of the psychomotor assessment fall into the "very good" category. This category is in accordance with the opinion of Arikunto (2012).

The handbook that was developed contains several pictures and a harmonious blend of colors so that this book can attract students and of course affect their learning outcomes. This is of course the same as the opinion of Ulfa et al. (2018) that interest can certainly make students more extensive in exploring new things within themselves so that they can learn more broadly and deeply. Basically, a good guidebook must have clear activity objectives referring to the cognitive, affective and psychomotor domains (Ulfa et al., 2018). However, the developed book already has activity objectives but only refers to the psychomotor domain and does not include other domains such as affective and cognitive so that further book development will be needed later.

The guidebook being developed focuses only on one material, namely the making of nata de coco so that this book cannot be used in other practicums as other guidebooks contain various practicum activities.

CONCLUSION

This research is a research on the development of a practicum guidebook for learning biology on making nata de coco at Private High School PAB 8 Saentis. From the data obtained, it can be concluded that: 1). The validation results from the validators, both the media expert validator and the material expert validator, responses from students and teachers, indicate that the handbook developed is valid and ready to be used for students. 2). The handbook developed can improve student learning outcomes where it can be seen from the average cognitive domain at the initial score of 46.32 and the final score is 78.12. In the psychomotor domain, students get scores in the "very good" category, with an average of 82 out of 100.

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