Development of Self-discovery and Exploration (SDE) Integrated Low Level Organism Taxonomy Teaching Materials to Improve Students' Critical Thinking Skills

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Abstract. This research aims to improve students' critical thinking skills through the development of self-discovery and exploration (SDE) teaching materials for low-level taxonomy of organisms. This material is a modified version that combines the concepts of Discovery Learning with the mapping of the Indonesian National Qualification Framework. The Indonesian National Qualification Framework consists of six tasks: Routine Tasks, Critical Journal Review, Critical Book Report, Mini-Research, Project and Idea Generation. This research is classified as research and development (R&D) under the ADDIE approach. Data collection techniques through interviews, questionnaires, media test results, and effectiveness tests. Interview sheets, questionnaires, effectiveness tests and media effectiveness tests were used as research instruments. Research data were analyzed by calculating the percentage of the media effectiveness test and the effectiveness of the media in improving students' critical thinking skills. Results showed that there was a significant difference in critical thinking learning outcomes between experimental and control groups classes with tcount of 29.453 on Monera material, 23,204 on Protista material, and 15,214 on Fungi material, while ttable of 1,697 on Sig. (2-Tailed) of 0.000 which indicates tcount > ttable; The acquisition of critical thinking results for experimental class students on each of these materials was 85.40%, 78.41%, 75.88% in the very high category, while control class students were 31.66%, 27.95%, 49.89% in the low category. Thus, it can be concluded that the teaching materials developed are effective in improving students' Critical Thinking Skills.

Keywords: Critical Thinking Skill · Low Level Organism Taxonomy · Self-Discovery and Exploration

1 Introduction

Critical thinking is a logical thinking skill that requires high-level reasoning, understanding, analysis, and evaluation of the information received. Critical thinking skills enable a person to make valid decisions and examine things critically [1]. It is important

to uncover facts and problems as the first step that a person must have in dealing with problems and obtain information that can be used to find solutions to these problems [2].

Critical thinking skills are important to have to support 21st century skills. This is because these skills direct students to make logical decisions through a quality intellectual process. This process contributes to developing characters who are ready to face global challenges that have high complexity in various fields [3]. Therefore, critical thinking skills play a role in honing rational thinking skills to address problems in making the right decisions to solve problems through analyzing information based on facts and compiling arguments correctly and systematically [4].

One way that can be implemented to improve Critical Thinking Skills is to apply the Discovery Learning model [5]. Discovery Learning is a discovery-based learning model that involves students in problem solving to develop knowledge and skills. Through this learning model, students are able to carry out scientific investigations. The characteristics of the learning model are exploration and problem solving study to create, integrate, and generalize knowledge, learner-oriented and centered learning, and the ability to combine new knowledge with existing knowledge [6]. Discovery Learning is implemented in six stages of learning syntax, namely: stimulation, problem statements, data collections, data processing, verification, and generalization critical. This learning model has the advantage of being able to activate and develop reasoning power through effective independent knowledge construction [7].

In developing graduate competencies that are oriented towards critical and creative thinking skills, the Indonesian education curriculum at the tertiary level implements the Indonesian National Qualifications Framework (KKNI) system. The system is a qualification tier framework that can integrate learning outcomes into higher education levels. In practice, the IQF system is implemented by facilitating student learning through six mandatory tasks that must be completed in each course [8]. The mandatory tasks in question are Routine Tasks, Critical Journal Reviews, Critical Book Reports, Mini Research, Projects, and Idea Engineering. Routine Assignments are assignments that instruct students to present and explore the material studied in a substantive unit of subjects. Critical Journal Review and Critical Book Report are assignments that encourage students to review and analyze the results of research and theoretical studies contained in journal articles and books. Meanwhile, Mini Research, Project, and Idea Engineering are assignments that encourage students to design, modify, and carry out research according to the field or topic that is being intensely studied and explored in the course [8].

The facts prove that the critical The thinking ability of Indonesian students is still relatively low. It is based on the results of the PISA survey, where Indonesian students ranked 72nd out of 78 participating countries in critical thinking skills with an average score of 379. Furthermore, a particular review that distributed questionnaires to students in the Department of Biology, Faculty of Mathematics and Sciences, Medan State University, showed that these students still had poor critical thinking skills, with an average score of 65.50%.

Observations on the topic of taxonomy of lower organisms in the Department of Biology, Faculty of Mathematics and Science, Medan State University indicate that there

is no available learning medium that can uniquely promote the development of students' critical thinking abilities. The textbooks used are traditionally written by subject teachers who place less emphasis on developing students' self-potential through learning, especially critical thinking. Therefore, in this study, we aim to develop low-level taxonomy teaching materials that integrate Self-Discovery and Exploration (SDE) as interactive teaching materials to improve the quality of teaching materials for taxonomy courses. Increase. The material is a combination of Monera, Protista, and Fungi concepts taught through an implementation of the Discovery Learning syntax suite supported by KKNI tasks. The results of this study are expected to help improve students' critical thinking skills. And explore students' self-efficacy in learning the Low Level Organism Taxonomy course.

2   Method

This research was conducted study at the Department of Biology, Faculty of Mathematics and Natural Sciences, Medan State University from October 2021 to May 2022. This research is classified as Research and Development (R&D) with the ADDIE approach which consists of five development steps, namely Analysis, Design, Development, Implementation, Evaluation. The population of the research subjects used were all students of the Department of Biology in 2021, which consisted of 9 classes with a total of 268 students. The population is used to analyze the potential needs for the development of teaching materials. The research sample used consisted of experimental and control classes, which consisted of two classes with 67 students. The sample is used to test the effectiveness critical of teaching materials in improving students' critical thinking skills.

The research design used a pretest-posttest control group design. The experimental praying and control classes were given a pretest to determine the initial state. After learning using teaching materials ended the experimental class and the control were given a posttest. Then, the pretest and posttest were compared to find out whether there was a significant difference. The questions used are oriented to the High Order Thinking Skill (HOTS) type. Data collection techniques used interviews, questionnaires, validation results of teaching materials, and test the effectiveness of teaching materials. The research instrument used interview sheets, questionnaires, validity tests, and test the effectiveness of teaching materials. The research data were analyzed by calculating the percentage of the media validity test. The results of the validation level obtained are then interpreted according to the following criteria (Table 1).

The effectiveness of the developed teaching materials was determined based on the t-test analysis of the experimental and control class posttest scores, analysis of students' critical thinking skills achievement, and the N-Gain significance test. Each test analysis was calculated using SPSS version 22 [9]. Students' critical thinking skills are measured through the following indicators (Table 2).

The results of the acquisition of the percentage of critical thinking skills are then interpreted based on the following Likert scale (Table 3).

The results of the students' N-Gain scores are interpreted according to the following criteria (Table 4).

Table 1. Media Validation Level Criteria

Percentage (%)	Information	Follow-up
76 – 100	Very good	New products are ready to be used in learning
51 – 75	Well	The product needs to be revised on a not too large and not basic scale
26 – 50	Enough	The product needs to be revised carefully and thoroughly by examining the weaknesses in the product
0 – 25	Not good	The product needs a major and fundamental revision

(Source: [19])

Table 2. Aspects and Indicators of Critical Thinking Skills Measured

Aspects	Indicators
Focus	Identify the problem
	Formulate the problem
Reason	Give an argument
	Give a logical reason
	Classifying something
Inferences	Formulate a hypothesis
	Summarizing the reasons accurately
Situation	Comparing problems with context
	Analyze data
Clarity	Clarifying argument presentation
	Draw a conclusion
Overview	Choose the possibility to be implemented
	Evaluating something that has been discovered or formulated

(Sources: [12, 23])

Table 3. Criteria for the Acquisition Level of Students' Critical Thinking Skills

Percentage (%)	Category
76 – 100	Very high
51 – 75	High
26 – 50	Low
0 – 25	Very Low

(Source: [11])

Table 4. Interpretation Criteria for N-Gain Score

Score g	Interpretation
g > 0,7	High
0,3 < g ≤ 0,7	Currently
g ≤ 0,3	Low

(Source: [33])

3 Results and Discussion

3.1 Analysis Stage

According to an interview with a lecturer in the Lower Level Organism Taxonomy course at the Faculty of Mathematics and Natural Sciences, Medan State University, the results can be seen in Table 5.

According to Table 5, it can be seen that the lecturer in charge of Taxonomy of Low-Level Organisms said that the teaching materials for these courses have shortcomings in terms of the structure of presenting the material, which is still presented conventionally

Table 5. Results of Interviews with Lecturers of Low Level Organism Taxonomy Courses Regarding Analysis of Potential Development of Teaching Materials

Aspect Question	Description
Teaching materials	The teaching materials used are still written by lecturers in a conventional or theoretical manner according to the Syllabus and Semester Learning Plans
	The teaching materials used are not specifically oriented to independent learning and improving students' critical thinking learning outcomes
	Students are highly recommended to access other teaching materials that are relevant to the topic of the material to support student understanding
	The current obstacle to teaching materials lies in the up-to-date aspect of teaching materials, for example, being more oriented to problem-analyzing skills and being able to contribute critically to solving these problems
Student exploration based on the assignment of the Indonesian National Qualifications Framework	An important thing is that students can explore their potential through the assignment of the Indonesian National Qualifications Framework which is integrated in teaching materials

which is only oriented to theoretical studies. This condition affects the quality of student learning outcomes, where students are less able to practice independence in learning because of the lack of learning activities that are concretely integrated in teaching materials. This situation also results in students not being able to optimally hone their critical thinking skills, namely by analyzing a problem and being able to provide solutions to these problems. Students are also not maximally able to explore their potential in completing tasks based on the Indonesian National Qualifications Framework which is the standard for achieving national competencies.

According to the questionnaire given to students, the results showed that as many as 69% of students agreed that the Lower Level Organism Taxonomy course had not yet been provided with teaching materials that could train independence in learning. As many as 97% of students agree that the Lower Level Organism Taxonomy course needs to be provided with teaching materials that are substantively integrated in modeling learning activities that are adaptive to constructivism learning systems. In addition, as many as 98% of students agree that they are more motivated in learning when using teaching materials that are directly integrated with mapping the tasks of the Indonesian National Qualifications Framework.

The solution that can be taken to deal with the above problems is to develop integrated learning materials for Discovery Learning and the assignment pattern of the Indonesian National Qualifications Framework. Teaching materials were chosen as a solution to course problems because they can train students' independent learning through learning activities that are integrated into the substance of the course material. This is in accordance with that teaching materials are teaching materials that are packaged systematically and contain a set of learning activities designed to help students achieve specific learning goals [10]. The learning objectives are specifically oriented to critical thinking skills that can be elevated through the application of Discovery Learning. The model is used as the main concept in constructing learning activities because the learning system is more focused on a constructivist approach to find out the concepts of the material being studied. This indicates that students carry out a systematic process of scientific investigation that also involves rational and reflective thinking about something that is being studied [11]. The same thing was also reported by that Discovery Learning is part of constructivism learning that provides opportunities for students to combine knowledge into structured learning activities that can accurately direct the thinking process. Meanwhile, the assignment of the Indonesian National Qualifications Framework is the main thing and must be passed by every student in Indonesia to achieve the curriculum goals and explore the maximum potential for self-exploration [12]. Based on this analysis, it can be understood that the development of teaching materials for the integrated Self-Discovery and Exploration (SDE) Taxonomy of Low-Level Organisms which is the creation of the combination of Discovery Learning and the assignment of the Indonesian National Qualifications Framework is an important thing to do [13].

3.2   Design Stage

Indicators of learning objectives for each material oriented to the achievement of students' critical thinking skills to be developed in teaching materials can be seen in Table 6.

Table 6. Indicators of Achievement of Learning Objectives for Each Material

Theory	Indicators of Achievement of Learning Objectives
Monera	Able to analyze the classification of bacteria based on the provision of nutrients
Protists	Able to solve problems based on facts or phenomena according to the classification of Animal-Like Protists
Fungi	Able to analyze the characteristics of fungi belonging to Oomycotina and Zygomicotina

Based on Table 6, it can be seen that the final design goal of learning through the teaching materials developed is that students are expected to be skilled at analyzing specifically the problems encountered and identifying information in order to plan problem solving solutions through reflective and constructive thinking. The identification of the information needed is obtained from a series of learning activities containing constructivism. This is in accordance that learning objectives oriented to critical thinking skills must be able to direct students to analyze, evaluate arguments, and correctly conclude the arguments obtained as a basis for solving problems [14].

Furthermore, the results of mapping learning activities according to the Discovery Learning syntax can be seen in Table 7.

Based on Table 7. it can be seen that the learning activities in the developed teaching materials are presented based on the Discovery Learning syntax which consists of six learning steps. The learning is based on the principle of constructivism, students are given the opportunity to organize their own learning to find concepts, data, facts, and information needed through observation and experimentation. This learning also directs students to investigate the facts learned in high-level reasoning in order to be able to select arguments and information to draw the right conclusions. The same thing was

Table 7. Discovery Learning Syntax Constructed in Teaching Materials

Learning Syntax	Description
Stimulation	Observing pictures and observing video links presented in teaching materials as a first step to understanding the problems to be solved in learning
Identification	Identifying species of lower organisms in the form of presenting hypotheses
Data collecting	Designing experiments and validating them on predefined pages
Data processing	Processing data findings obtained from the application of experiments that have been designed
Verification	Verifying the findings through the presentation of subject matter, biological information, and research references which essentially facilitate students in conducting a review of the experimental process that has been carried out
Generalization	Generalize the material that has been studied accompanied by a summary of the material, self-reflection, and practice questions

also explained by that Discovery Learning facilitates students to explore their abilities in problem solving by combining and generalizing learner-centered knowledge. Students have the opportunity to actively participate in constructing knowledge in new and meaningful learning situations [15].

Meanwhile, the distribution design for the assignment of the Indonesian National Qualifications Framework presented in the developed teaching materials can be seen in Table 8.

According to Table 8, it can be understood that there are six tasks based on the Indonesian National Qualifications Framework that are constructed in the teaching materials developed. The assignments consist of assignments related to research, namely Mini Research, Project, and Idea Engineering; assignments related to critical analysis or in-depth reviews of books and journal articles consisting of Critical Book Reports and Critical Journal Reviews; and assignments related to evaluation in problem solving as Routine Tasks that must be done by students.

The literature used to construct the material in the teaching materials developed is sourced from International Books and Journal Articles of International Reputation that are relevant to the topic of discussion. Books and Journal Articles on an international scale are selected to ensure the quality of the content of the teaching materials and the accuracy of the data and concepts used. This is because the literature sources have met high quality control and legality as a reference in teaching materials. This is in accordance that the higher the legality of the literature sources used, the better the quality of the reading materials to be designed. This is because quality literature sources have a better

Table 8. Assignment of Indonesia's National Qualifications Framework that is Integrated in Teaching Materials

Theory	KKNI Assigned Tasks	Description
Monera	Critical Book Report	Analyze the classification of bacteria according to the provision of nutrients through in-depth review and critical analysis of the E-Book
	Idea Engineering	Designing techniques for utilizing beneficial bacteria and preventing harmful bacteria through in-depth Idea Engineering
Protists	Routine Tasks	Evaluate and solve problems related to the classification system and phenomena of animal-like protists
	Project	Designing a mechanism for the utilization of plant-like protists based on an evaluation of the problems caused by macroalgae in Indonesia
Fungi	Critical Journal Review	Analyzing the characteristics of Oomycotina and Zygomicotina through in-depth reviews and critical analysis of journal articles of international repute
	Mini Research	Constructing the use of fungi in their respective areas that become local potentials through mini experiments

level of validity because they have gone through a careful and accurate review from a team of expert reading sources [16].

3.3 Development Stage

The developed book consists of three chapters of material, namely Monera, Protista, and Fungi. The physical appearance and content of the book can be seen in Fig. 1.

Based on the results of the development that has been carried out, it can be seen that the physical appearance of teaching materials consists of four main parts, namely the cover, sub cover of each material, learning steps, and the assignment format of the Indonesian National Qualifications Framework. The cover section contains elements of the course title, author's name, and relevant images to represent the contents of the teaching materials. This is in accordance with [17] that the outer cover of teaching materials should provide information about titles that represent the overall picture of the contents of teaching materials, author's name, and representative images relevant to the content of teaching materials, so that readers are able to capture the initial presentation that describes the entire content of teaching materials [18]. The sub cover section of the material presents the main title of the material that is the focus of the discussion to be studied and is equipped with a representative image of the material. The material in question consists of Monera, Protista, and Fungi. The learning steps section contains the stages of learning that must be followed by students. The learning stages follow the Discovery Learning syntax. Furthermore, it is equipped with a format for working on the Indonesian National Qualifications Framework assignments and practice questions to explore students' understanding related to the material being studied while at the same time measuring students' critical thinking reasoning independently.

The teaching materials developed were then validated by three validators, namely the material expert validator, the linguist validator, and the question expert validator. The results of the validation of teaching materials according to expert validators in each validation aspect can be seen in Table 9.

According to material validation by material expert validators, the percentage of validity is 94.50% with a very good category. This shows that the content of the material
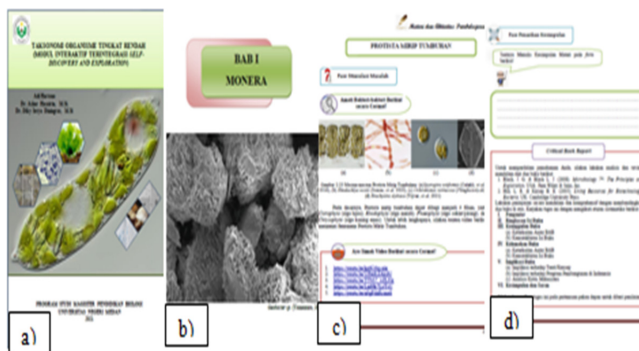

Fig. 1. Display of Teaching Materials Developed: a) Cover of Teaching Materials; b) Cover Material; c) Learning Syntax; d) Assignment of the National Qualifications Framework

Table 9. Results Validation of Teaching Materials Integrated Low Level Organism Taxonomy by Self-Discovery and Exploration (SDE)

Aspect of Validation	Percentage Validity (%)	Category
Material validation	94,50	Very good
Language validation	92,18	Very good
Validation of teaching materials	89,84	Very good

presented in the teaching materials can be utilized in learning. The same thing was also expressed by that the results of material validation with a very good category indicate that the substance of the material in the media has met the feasibility of being a learning resource by students [19].

According to language validation by linguist validators, the percentage of validity is 92.18% with a very good category. This indicates that the use of language in the developed teaching materials has been presented in a structured manner using good language rules. The same thing was also reported that the presentation of language in the very good category according to the validator of linguists shows that the use of language in the media has fulfilled the clarity of sentence structure and the use of good grammar rules according to the applicable language rules [20].

According to the validation of teaching materials by expert validators of teaching materials, the percentage of validity is 89.84% with a very good category. This indicates that the teaching materials developed have met the criteria for good teaching materials to be implemented in learning. This is in line with teaching materials with very good quality according to teaching materials experts indicate that the media has been qualified to be applied in learning to train students' independence in learning [21].

3.4 Implementation Stage

After the teaching materials are declared valid according to the expert validators, the teaching materials are implemented in learning to determine the level of effectiveness of the media in improving students' critical thinking learning outcomes. The trial of this teaching material was carried out using two classes, namely the experimental class and the control class. The experimental class is a class that gets treatment with teaching materials by applying the Discovery Learning model and the assignment of the Indonesian National Qualifications Framework as presented in the teaching materials. Meanwhile, the control class is a class without treatment of teaching materials with learning delivered conventionally through the lecture method by researchers. This is in accordance that the control class serves as a reference class to compare the presence or absence of significant learning outcomes from the applied treatment. At the beginning of the lesson, the researcher gave a HOTS-based pretest to students in the two classes. After the lesson ended, the researcher gave a posttest to measure the achievement of students' critical thinking skills [22].

Table 10. Normality Test Results of Experiment Class Students' Posttest Values

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
Monera	,220	31	,071	,885	31	,083
Protista	,198	31	,093	,834	31	,080
Fungi	,277	31	,270	,798	31	,470

a. a. Lilliefors Significance Correction

Table 11. Normality Test Results of Control Class Students' Posttest Values

Tests of Normality

	Kolmogorov-Smirnov[a]			*Shapiro-Wilk*		
	Statistic	df	Sig.	Statistic	df	Sig.
Monera	,165	33	,230	,944	33	,088
Protista	,146	33	,074	,915	33	,130
Fungi	,255	33	,670	,805	33	,750

a. Lilliefors Significance Correction

3.5 Evaluation Stage

At this stage, a thorough evaluation of the effectiveness of the teaching materials developed to improve students' critical thinking skills is carried out as well as the response of lecturers and students to the media. Evaluation of the effectiveness of the media is carried out in two ways, namely analyzing whether there is a significant difference between the learning outcomes of critical thinking students in the experimental and control classes through t-test analysis on posttest scores, analyzing the percentage of achievement of learning outcomes based on critical thinking indicators measured, and analyzing the significance test. N-Gain. However, the normality test and homogeneity test were carried out first as a condition to carry out the t test. Each of these test analyzes can be described as follows.

3.5.1 Normality Test

The results of the posttest normality test of the experimental class can be seen in Table 10.

According to the posttest normality test of the experimental class students above, the result is that the Sig. > 0.005 value for each material. Based on this, the posttest scores of the experimental class students were normally distributed. Furthermore, the results of the posttest score analysis of control class students can be seen in Table 11.

Table 12. Results of Homogeneity Test of Posttest Values for Control Experiment Class Students

	Test of Homogeneity of Variances			
Materi	*Levene Statistic*	*df1*	*df2*	*Sig.*
Monera	,064	1	62	,801
Protista	8,483	1	62	,075
Fungi	,224	1	62	,638

According to the posttest normality test of the control class students above, it was found that the value of Sig. > 0.005 for each material. Based on this, the posttest scores of the control class students were normally distributed.

3.5.2 Homogeneity Test

The results of the homogeneity test of the experimental and control class students' posttest scores can be seen in Table 12.

According to the homogeneity test of the posttest scores of the experimental and control class students above, it was found that the Sig. > 0.005 value for each material. Based on this, the posttest scores of the experimental and control class students were homogeneous.

3.5.3 T Test

Based on the normality test and the homogeneity of the posttest scores of students, it is known that these values are normally distributed and homogeneous, so a t-test can be performed to determine whether there are significant differences in the results of critical thinking between experimental and control class students. The results of the t-test calculations can be seen in Table 13.

Based on the t-test above, it was found that the value of tcount > ttable on Sig. (2-Tailed) of 0.000. This shows that Ha which reads that there is a significant difference in critical thinking learning outcomes between experimental and control class students is accepted. Meanwhile, H0 which reads that there is no significant difference in critical thinking learning outcomes between experimental and control class students is rejected.

Table 13. Results of T-Test Posttest Values for Experimental and Control Class Students

Theory	Tcount	Ttable	Sig. (2-*Tailed*)
Monera	29,453	1,697	0,000
Protists	23,204	1,697	0,000
Fungi	15,214	1,697	0,000

Table 14. Average Percentage of Students' Critical Thinking Skills Achievement

No.	Classes	Theory		
		Monera	*Protists*	*Fungi*
1.	Experiment	85,40%	78,41%	75,88%
	Category	Very high	Very high	Very high
2.	Control	31,66%	27,95%	49,89%
	Category	Low	Low	Low

3.5.4 Accuracy of Achievement of Students' Critical Thinking Skills

The accuracy of the achievement of students' critical thinking skills according to critical thinking indicators can be seen in Table 14.

Based on Table 14, it can be understood that the experimental class students have a very high average critical thinking skill achievement, while the control class has a low category for each material studied using the developed teaching materials.

3.5.5 N-Gain Significance Test

The results of the N-Gain significance test on the acquisition of students' cognitive learning outcomes can be seen in Table 15.

The significance results of the N-Gain above show that experimental class students have a N-Gain value with a high category for each material. Meanwhile, control class students have a low category of N-Gain on Protista material and medium categories on monera and fungi material.

Based on the evaluation of the effectiveness of the teaching material above it can be understood that there is a significant difference between posttest acquisition, accuracy of the achievement of learning objectives, and the significance of the N-Gain between the experimental and control class, where the acquisition of critical thinking skills in the experimental class in each of these aspects is higher. The control class, it can be concluded that the teaching material developed is proven to be effective in increasing the critical thinking skills of students [23].

Table 15. Significance of N-Gain for Experiment andControl Class

No.	Classes	Theory		
		Monera	*Protists*	*Fungi*
1.	Experiment	0,85	0,78	0,75
	Category	High	High	High
2.	Control	0,31	0,27	0,49
	Category	Currently	Low	Currently

In this case, there are several reasons for self-discovery and exploration (SDE) teaching materials developed can increase student critical thinking skills. First, the teaching material developed can facilitate students to think of finding concepts or principles in a structured manner with discovery learning. Second, the teaching material can accommodate the active role of students through constructivism learning. Third, the teaching material developed can mediate the problem of solving the problem independently through exploration of in -depth understanding through the assignment given [24]. These reasons are similar that the integration of discovery learning in teaching media can facilitate scientific learning by developing critical thinking and active ways of learning students to find and investigate the concepts learned, so that things that have been obtained can last longer [25]. For also initiated that discovery learning -based learning can improve superior results in the thought process of students because students are trained to accustom the problem solving skills at a high level [26]. Emphasized that a combination in the implementation of discovery learning and appropriate assignments can practice the critical thinking power of students because students are faced with a systematic process in completing tasks that can provide opportunities for students to formulate and evaluate, provide explanations, Observe, and induce their own knowledge and arguments [27]. The purpose of the appropriate assignment is the KKNI assignment consisting of six structured tasks that can explore the potential of students more deeply related to the material being studied [28].

According to the lecturer's response to the development of teaching materials, the results obtained that the lecturer in the taxonomy of low-level organisms agreed that the material in teaching materials had been presented clearly and had explored the sharp discussion studied at each meeting. The lecturer also holds that the language used is very easy to understand and in accordance with the character of student psychological development [29]. The glossary that is presented is also very helpful for students to better understand the material presented. The learning activities contained in teaching materials are also in accordance with the syntax of discovery learning as well as the substance and exposure of information contained in teaching materials have also been relevant to the concept of self -exploration of students based on KKNI [30]. Tata layout has been well designed, but there is a need for additional elements of attractive graphics information in teaching materials and visual presentation. The questions used have also functioned well and are relevant to the measurement of student learning outcomes[31].

Based on student responses to the development of teaching materials, the results are obtained that all students (100%) agree that the material presented is easy to understand and the technique of presenting material can practice learning independence. As many as 97% of students agree that the teaching materials developed were arranged using clear, comprehensive, effective, and the use of visual appearance symbols that facilitate understanding. As many as 97% of students agree that the teaching materials developed are beneficial to improve material insight and be useful in facilitating the development of their potential through exploration of the material being studied. As many as 93.9% of students agree that the teaching material developed can help the discovery -based learning process (discovery learning) and help facilitate the learning process to support the achievement of KKNI assignments. All students (100%) agree that the teaching material developed is able to hone critical thinking skills [32].

States that if the teaching material developed received a positive response from lecturers and students implies that the teaching materials have been worthy of being applied in learning and are useful for improving student learning outcomes [33]. Also explained that if the teaching material developed received a positive welcome from the lecturer and student indicated that the teaching material was said to be feasible for use and had met the elements and criteria of good teaching materials. Based on this, teaching materials developed in this study are suitable for use in the Low Level Organism Taxonomy course to improve the 21st century skills of students [34].

4   Conclusion

Based on the research that has been done it can be concluded that the development of teaching materials for low-level organisms integrated Self-Discovery and Exploration (SDE) is an important thing and is needed to improve students' critical thinking skills according to interviews with lecturers in courses and questionnaires given to students. The teaching material developed is a combination of the discovery learning model with the assignment of the Indonesian national qualification framework integrated in the Monera, Protista, and Fungi material. The teaching material developed consists of four main components, namely the cover, sub-cover of each material, learning steps, and the format of the Indonesian National Qualification Framework. Based on the effectiveness of the effectiveness of teaching materials there are significant differences in critical thinking learning outcomes between the experimental class and control with the tcount of 29,453 on the monera material, 23,204 on the protist material, and 15,214 on the fungi material, while the ttable is 1,697 in sig. (2-tailed) of 0,000 which shows tcount > ttable; acquisition of critical thinking results of experimental class students in each material in sequence of 85.40%, 78.41%, 75.88%with very high categories, while control class students are 31.66%, 27.95%, 49.89% with a low category. Thus, it can be understood that teaching materials developed are effective in increasing the critical thinking skills of students.

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