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BOTANICAL MATERIALS DEVELOPMENT: INTEGRATING OF SCIENCE LITERACY AND LOCAL WISDOM

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Abstract

The development of good learning resources on science literacy learning based on local wisdom as a strategy to facilitate active learning that can design science concepts contextually with real situations and become the current 21st-century learning trend. Critical thinking skills are needed as a strategy to build the competence of higher-order thinking skills and discovery needed in science learning. This study aims to develop learning tools on science literacy learning based on local wisdom ota botanical materials that can improve students' critical thinking skills. The study was conducted through a mixed method with the type of research model developed by Borg and Gall and the application of teaching materials in the classroom. This research was conducted by involving 6 expert validators, 4 teachers, 12 students for respondents and 120 students from 4 different schools in Langsa City, Aceh Province for implementation. The research data are presented as the results of the feasibility of teaching materials, teacher and student responses through questionnaires and the results of critical thinking assessment using tests. The results showed that the development of science literacy teaching materials based on local wisdom is feasible for use in the student environment and the average score of critical thinking skills of high school students in Langsa City after the application of science literacy teaching materials based on local wisdom has increased with the achievement of a score of 87.

Keywords: Science Literacy, Local Wisdom, Ethnobotany, Critical Thinking Skills, Students Achievement

INTRODUCTION

Science is learning that is obtained through evidence or knowledge that can be proven by the scientific method (Zidny and Eilks, 2018). Science is seen as a collection of knowledge from the discoveries of scientists who are systematically collected and then grouped based on their fields of study, namely physics, chemistry and biology. The collection of knowledge is in the form of facts, concepts and legal principles. Effective science learning is designed contextually by presenting real situations so that students can easily define abstract concepts (Gregorcic, et al. 2017). One of the efforts is to facilitate students by linking various physical, social and

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cultural experiences. Teachers must innovate in inserting local culture in the science learning process.

Indonesia's literacy level is low (Suparya et al., 2022). Some other evidence can be seen from the 2019 Program for International Student Assessment (PISA) rankings from the Organization for Economic Co-operation and Development (OECD). Indonesia is ranked 62 out of 70 countries or among the ten least literate countries globally (Ilham, 2022). That statement is reinforced by research conducted on four countries studied in Japan in 2009: Japan, Sri Lanka, America, and Indonesia. Indonesia has a very poor literacy level (Chandra, 2021).

Education in Indonesia, the recommendation is contained in the Government Regulation on Primary and Secondary Education Process standards which contains the preparation of Learning Plans should pay attention to individual differences consisting of initial abilities, intelligence levels, talents, academic potential, interests, cultural backgrounds and the environment of students so that learning is more meaningful (El Islami, et al., 2016). One of the major components in this is science creating learning outcomes and results, which include the profile of the learners who obey their orders creators, love each other, and care about each other a civilized environment, which in turn will be a civilized environment (Koizumi, 2017). To achieve this, it is necessary to have a relevant and quality education science (Karim et al., 2017).

The science learning process is inseparable from a series of processes to achieve students' scientific competence. A knowledge, scientific skills, explaining phenomena in the surrounding environment and understanding the characteristics of science is the definition of scientific literacy. Learning is close to the student, interwoven with their surroundings and social culture (Rohman, et al., 2017). Currently, the ability of science literacy in education in Indonesia has not been achieved optimally as evidenced by the Program for International Student Assessment (PISA) data. As for the development of PISA results in 2018, especially in science literacy, Indonesia ranks 70 out of 78 countries (OECD, 2018). These results show that Indonesia's average science literacy score is below the average international score. It can be stated that the picture in the practice of science literacy implementation process is not optimal (Lederman, et al., 2013). Based on previous research, at the elementary school level, 70% of fifth grade students in one elementary school have low science literacy skills (Winata, Cacik, and Seftia, 2018). Problems at the elementary school level are similar to problems in junior and senior high school. Learners have not been able to optimally create graphs based on data and solve problems using quantitative skills including basic statistics.

Science literacy needs to be developed early on so that simultaneously students have increasingly complete competencies. Potential science literacy can be developed through teaching materials and learning to identify everyday phenomena. Talking about the suitability of teaching materials with their users cannot be separated from the activities or activities carried out by students in social life. This habit is called local wisdom. Local wisdom refers to knowledge derived from community experience and is an accumulation of local knowledge (Didied, 2012).

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Most researchers have conducted research on local wisdom-based learning (Hidayati, et al., 2012; Uge, et al., 2019; Nurhamid, et al., 2021). A number of researchers have studied the development of teaching materials such as modules and textbooks for science learning, such as physics learning (Wardani and Mundilarto, 2021), biology learning (Suratno, et al., 2020; Budiarti & Harlis, 2020 and Hadi, et al., 2020), chemistry learning (Anugrah, 2021; Kiwfo, et al., 2021) and math learning (Ulya & Rahayu, 2021; Kurniawan & Kusmato, 2021). Some researchers have also studied the implementation of local wisdom-based learning processes in social studies subjects (Sayono, et al., 2020; Tahir, et al., 2020).

In addition, several researchers have studied the implementation of local wisdom-based character education to build the character of students as individuals who have positive attitudes and behaviors (Hidayati, et al., 2020). Local culture-based learning also has a positive effect on students' critical thinking and communication levels (Sutiani, et al., 2021). Of the many studies on local wisdom-based learning, studies related to science literacy in learning Biology botanical material seem to be minimal. Therefore, the development of studies on local wisdom-based learning and mapping the scope of science literacy learning must be carried out to ensure that studies related to science literacy based on local wisdom in biology learning on students' critical thinking skills are still rare.

For this reason, it is necessary to prepare professional teachers through the application of quality teaching materials by introducing the concepts of literacy and character in a disciplined manner into the classroom. Science literacy based on local wisdom describes science learning through strategies, science objectives, content, and science processes with existing environmental phenomena. The development of science literacy teaching materials based on local wisdom applied to students will create meaningful learning and create a person who has the ability to think scientist in the future. If they have high or premium quality, we can predict the quality of society in the future. Based on previous research there has been no research that develops local wisdom-based science literacy teaching materials on botanical science materials, so this research is very important and new. This study aims to determine students' critical thinking skills through the application of local wisdom-based science literacy teaching materials on botanical materials. The findings will help educators to promote local wisdom-based science literacy teaching materials on botanical materials to students and prepare students to have the ability of 21st century skills, namely critical thinking.

METHOD

Research Design

This study investigates the effectiveness of the application of science literacy teaching materials combined with local wisdom on botanical materials for high schools in Aceh. The research approach used in this study is a mixed method, which is a combination of qualitative and quantitative approaches. The type of research used is development research by adopting the model developed by Borg and Gall, including: (1) preliminary study; (2) product design; (3) product design validation; (4) product design revision; (4) product testing; (5) product revision; (6) usage test; (7) product design revision; and (8) final product report.

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This research was conducted in stages (1) conducting observations and interviews related to the use of teaching materials with biology teachers in several high schools in Langsa City, Aceh Province, (2) determining teaching materials by considering input from the observed and interviewed teachers, (3) analyzing the material and compiling the material by analyzing the local wisdom of the Langsa City community according to the predetermined material, (5) analyzing the syntax of science literacy, (6) determining indicators of students' critical thinking, and (7) validation and small group trials.

Data Collection and Analysis

The population in this study were all high school students in Langsa City, Indonesia. The research sample consisted of 4 high schools in the 2021/2022 academic year section. The subjects of this study were teachers and high school students in Langsa City. This location was chosen because Langsa City is a coastal area where there are many mangrove forests which are leading tourist destinations. There were 30 students in each experimental and control group for implementation. The sampling technique in this study used cluster sampling because the sample members of the population were larger, so the samples were taken based on predetermined groups (Sugiono, 2015).

This research instrument consists of: (1) assessment sheet (questionnaire) of science literacy based on local wisdom; (2) validation of the feasibility of teaching material sheets. Expert validation was validated by 6 material expert validators, teacher responses were validated by 4 teachers consisting of four high schools in Langsa City. While student responses were filled in by 12 students consisting of four high schools in Langsa City, each of which contributed 4 students. Validation and content analysis were carried out to standardize the quality of developing botanical teaching materials with the aim of assessing the suitability and feasibility of the learning model with the target of achieving critical thinking and academic competencies. Standardization and validation of the developed learning materials were carried out using expert judges (validators) who had experience teaching ethnobotany. A pilot test was conducted for a small number of students to validate the feasibility of the developed teaching materials. Revision of the teaching materials was also carried out followed by the validation results along with the suggestions given by the validators. Comments given by respondent experts were then used to improve the learning model until the final product of standardized learning materials and supporting materials was obtained for classroom use.

The assessment instrument measures students' critical thinking using multiple choice questions (15) critical thinking test items (environmental literacy test items). The questions were given to class XI students with a total sample of 120 students consisting of 4 public high schools in Langsa City. These questions are arranged based on the indicators of each component with a 0-1 rating scale, a rating scale of 1 for the correct answer and 0 for the wrong answer. This test is given to students at the end of learning. Critical thinking skills data is obtained based on cumulative assessment of critical thinking aspects (interpretation, analysis, inference, evaluation, and extension) with a rating scale of 0-100. Data is presented in the form of learning outcomes, namely students' critical thinking skills. Student learning completeness is measured by competency achievement seen from the learning outcomes. Students who have achieved >75

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learning outcomes are classified as competent. The following is the instrument grid used to obtain critical thinking literacy data in Table 1.

Table 1: Critical Thinking Test Instrument Lattice

No	Aspect of critical thinking	Description of critical thinking skills	Indicator of science literacy based on local wisdom on botanical material	Item
1	Interpretation	The skills to understand and express the meaning contained in the facts, information and the data obtained from observation	Knowledge of current environmental issues	1-3
2	Analysis	The skills to identify the meaning and the actual inferential relationships between the data, the statements, the questions, the concepts, or other forms obtained in learning activities	Describe the components of ecosystems in the seas off the east coast of Aceh	4-7
3	Inference	The skills to make predictions based on the results of identification and to conclude logically and precisely	Classifying various ecosystems and explaining how to manage Aceh's mangrove forests	8-10
4	Evaluation	The skills to assess the quality of the statements and other explanatory representations	Explain the relationship between interactions between ecosystem components in the Aceh mangrove forest	11-12
5	Expansion	The skills to present reasoning and justify convincing arguments based on the data or the concepts	Conclude that in nature, if there is an imbalance of ecosystem components, rehabilitation efforts must be made so that the balance of processes can take place.	13-15

RESULT AND DISCUSSION

Result

Local wisdom-based science literacy teaching materials on botanical materials have been developed and equipped with complementary materials such as learning media, learning procedures, assignments, and evaluation tests to investigate students' critical thinking levels. Standardization of the developed teaching materials has also been carried out using validators, and the results are listed in Table 2. The quality of the teaching materials developed according to the respondents' opinions was determined as very good (average >3.50). The teaching materials prepared meet the eligibility criteria for learning tools to be used in the teaching-learning process for botanical materials.

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Table 2: List of validation result data based on material expert assessment of local wisdom-based science literacy teaching materials on botanical materials

No.	Rating of Experts Material	Number of Item	Score	Mean	Categories
1	**Content Feasibility**				Feasible
	Suitability of the Material with KI and KD	2	7	3.5	
	Accuracy of Material	2	8	4	
	Evidence of Material	2	7	3.5	
	Encourage curiosity	1	3	3	
2	**Presentation Feasibility**				Feasible
	Presentation Technique	2	7	3.5	
	Presentation Support	3	11	3.7	
	Presentation of Learning	2	7	3.5	
	Coherence and Flow of Thought	2	8	4	
3	**Contextualized Assessment**				Feasible
	Presentation Technique	2	7	3,5	
	Contextual Components	2	7	3.5	
4	**Feasibility of Graphics**				Feasible
	Teaching Material Size	2	7	3.5	
	Cover	2	8		
	Teaching Material Design	2	7	3.5	
5	**Feasibility**				Feasible
	Straightforward	2	7	3.5	
	Communicative	2	7	3.5	
	Total Score			**59.7**	
	Mean			**3.31**	
	Percentage (%)			**82.7%**	
	Categories				**Feasible**

Table 3: List of data on the results of teacher responses to local wisdom-based science literacy teaching materials on botanical materials

No.	Rating of Experts Material	Number of Item	Score	Mean	Categories
1	**Language Feasibility**				Feasible
	Straightforward	2	7	3.5	
	comunicative	2	8	4	
	Interactive dialogue	2	7	3.5	
	Appropriateness to learner development	2	7	3.5	
	Symbol	2	6	3	
2	**Feasibility of Graphics**				Feasible
	Presentation Technique	2	7	3.5	
	Presentation Support	1	3	3	
	Presentation of Learning	1	3	3	
	Coherence and coherence of thought	1	3	3	
	Total Score			**30**	
	Mean			**3**	
	Percentage (%)			**75%**	
	Categories				**Feasible**

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Table 4: List of data on the results of student responses to local wisdom-based science literacy teaching materials on botanical materials

No.	Rating of Experts Material	Number of Item	Score	Mean	Categories
1	Contextual Assessment	3	11	3.7	Feasible
2	Graphics Feasibility	3	10	3.3	Feasible
3	Content feasibility	4	15	3.75	Feasible
	Total Score			**10.7**	
	Mean			**3.6**	
	Percentage (%)			**90%**	
	Categories				**Feasible**

Table 5: Students' critical thinking skills after completing the learning of local wisdom-based literacy teaching materials on botanical material

No.	Name of School	Number of Student	final evaluation test	Competence Summary
1	SMAN 1 Langsa	28	90	Competence achieved
2	SMAN 3 Langsa	32	88	Competence achieved
3	SMAN 4 Langsa	26	86.7	Competence achieved
4	SMAN 5 Langsa	34	83.2	Competence achieved

Table 6: Students' critical thinking skills indicator

No.	Name of School	Critical thinking indicator					Student Critical Thinking (%)
		Interpretation	Analysis	Inference	Evaluation	Expansion	
1	SMAN 1 Langsa	90	92	86	90	94	90
2	SMAN 3 Langsa	92	83	89	88	90	88
3	SMAN 4 Langsa	86	88	90	86	85	86.7
4	SMAN 5 Langsa	85	84	84	83	80	83.2

DISCUSSION

Learning using wisdom-based science literacy greatly affects students' thinking skills in botanical materials (Hadi, et al., 2019; Ardan, et al., 2015). The development of science literacy teaching materials based on botanical local wisdom that has been developed helps teachers and students in the learning process. The teacher will not be fixated on objects or examples that are only in the book, but the teacher can show real objects or examples that are in the environment around the students themselves. Biology teachers must be able to present these objects in a real way both in class and structured tasks outside the classroom (Sari, et al., 2019). The teaching materials developed are teaching materials expected to be able to provide learning experiences for students well, because learning biology is inseparable from nature and living things in it so that teaching the material can improve students' critical thinking skills.

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The teaching materials developed have been validated by material experts and media experts. The results of the teaching materials developed are feasible and valid, so it is feasible to be implemented for class XI high school students. The results of the material expert validation in the form of an overall score percentage of 82.7%. The results of the material aspect show that the teaching materials are suitable for use. The results obtained are inseparable from the contents of the book which contains contextual material and is accompanied by visual images contained in teaching materials that have a positive effect on the ease of students to read and can increase understanding (Sumarni, et al., 2017; Saira, et al., 2021). The overall teacher and student response assessment results obtained a percentage score of 80% and 90%. These results indicate that the teaching materials are suitable for use. There are four aspects that must be considered in order for the design to attract teaching materials, namely contrast, layout, typesetting, and image design. These four aspects will determine the process of delivering messages in student teaching materials.

Science literacy teaching materials based on local wisdom on botanical materials developed are able to guide students to carry out scientific activities and produce develop students' critical thinking skills through strategies, science objectives, content, and science processes with existing environmental phenomena. The attitude and level of student engagement in learning is highly dependent on the mastery of science literacy. Critical thinking skills such as interpretation, analysis, inference, evaluation, extension have been developed according to student competencies (Shaw, et al., 2019; Jiang, et al., 2018; Kleinig, 2018). Learning through inquiry motivates students to learn independently and brings them a clear understanding of ecosystem materials (Jiang, et al., 2018; Situmorang, et al., 2018; Madhuri, Kantamreddi & Prakash Goteti, 2012). Students have been able to ask questions, form hypotheses, design experiments to test hypotheses, collect data, draw conclusions as a result of mastering science literacy. The ability to think critically scientifically is formed systematically for students when doing academic and work activities. Critical thinking skills are also a good culture for prospective teachers sampled in this study, which can be transmitted to students when they teach science in the classroom.

The implementation of science literacy materials based on local wisdom has proven to be very effective in systematically guiding students to learn chemistry (Ayyildiz & Tarham, 2018; Simaremare, Situmorang & Tarigan, 2018; Sutiani, et al., 2017). This learning has successfully motivated students to actively learn ethnobotany and resulted in improved critical thinking skills (Kahlke & Eva, 2018). The syntax provided in science literacy has proven to be very effective in bringing students to understand botanical materials. The inquiry procedures designed to be integrated in the learning materials are considered very effective in bringing students to do scientific work (Tarhan, et al., 2013; Lyons, Halton & Freidus, 2013; Sutiani, et al., 2021). Through various investigations and observations made during learning activities, it was able to draw questions from them regarding Aceh's local wisdom which is now a tourist attraction, and can organize plans for scientific investigations of existing ecosystem equilibrium. The results show that critical thinking skills in the aspects of collecting experimental data and interpreting data results are well developed (Toharudin & Kurniawan, 2019; Styers, et al., 2018). Local wisdom applies the principle of reflection to students to focus

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on real life and complex problems for them to solve through self-awareness, critical thinking, problem solving, communicating, collaborating and independent learning (Dahliani et al., 2015; Hasanah et al., 2016; Hestiana & Rosana, 2020). Students can identify experimental variables, to analyze the relationship between various data, to present results in the form of concepts and graphs/tables, and assess the credibility of statements to answer the proposed hypothesis. The students can justify reasoning in the form of convincing arguments based on data on phenomena in the field, build new knowledge related to the subjects they study, and draw conclusions in a logical way. Students have had the ability to think critically perform academic activities which in turn improve learning outcomes. This study has shown that the application of local wisdom-based science literacy teaching materials developed improves critical thinking skills and student achievement in botanical materials, and ultimately the desired competencies can be achieved (Sinaga, Situmorang & Hutabarat, 2019; Situmorang, et al., 2018; Virtanen, Niemi & Nevgi, 2017).

CONCLUSION

Standardized and systematic local wisdom-based science literacy teaching materials have been developed for teaching botanical materials. The students are very interested and motivated to use the developed teaching materials, namely learning activities become active and critical thinking skills are maximized. Local wisdom-based science literacy teaching materials are proven effective for developing students' critical thinking. The developed teaching materials help students to increase knowledge and understand the botanical material being studied. Furthermore, these teaching materials bring students involved in problem solving through environmental and ecosystem phenomena observed. This teaching material has a significant contribution to improving students' critical thinking skills in biology and ultimately improving achievement. It is expected that materials that require skills can develop and implement local wisdom-based science literacy teaching materials because they have been proven to be able to improve students' critical thinking skills, which contribute to facilitating students' active and critical learning, which in turn improves their learning outcomes.

Authorship Contribution Statement

Nursamsu: Concept, design, drafting, data analysis.

Raja Novi Ariska: data acquisition, data interpretation

Binari Manurung: Content validation, supervision, final approval

Hasruddin: Critical revision of manuscript, Supervision

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