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Local wisdom-based teaching materials to improve student problem-solving

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ABSTRACT

Improving students' problem-solving skills can be done through teaching materials. Teaching materials used in schools throughout Indonesia have not been integrated with local potential or wisdom. This research aims to develop teaching materials based on local wisdom to improve students' problem-solving abilities. The local wisdom raised in the teaching materials is the local wisdom of agriculture in Binjai Medan and the Balinese environment based on the local wisdom of the Tumpek Wariga ceremony. The development of teaching materials uses the ADDIE design model (Analyze, Design, Develop, Implement, Evaluate). The implementation phase uses a quasi-experimental method with a non-equivalent control group design in a high school located where the local wisdom applies. The results showed that the feasibility test of teaching materials and the readability test showed that teaching materials based on local agricultural wisdom in Binjai were 83.643% (very feasible) and 77.13% (high). In contrast, environmental teaching materials in Bali were based on local wisdom Tumpek Wariga. Successively very feasible (88.10%) high (95.39%). Students' problem-solving ability has increased with an N-gain of 0.67 (medium) on teaching materials based on local agricultural wisdom in Binjai and 0.71 (high) in Balinese environmental teaching materials based on Tumpek Wariga. The study results showed that teaching materials based on local wisdom of Agriculture in Binjai and Tumpek Wariga in Bali were valid and could improve students' problem-solving skills on Ecosystem and Environmental Change materials.

Introduction

The era of globalization has a fairly broad impact in various aspects of life, including the demands in the implementation of education (Wijaya et al., 2016). The 21st century learning framework includes: (1) critical thinking and problem-solving skills, able to think critically, laterally, and systematically, especially in the context of problem solving; (2) the ability to create and renew (creativity and innovation skills), able to develop their creativity to produce various innovative breakthroughs (P21, 2007). One

of the skills emphasized in 21st century skills is problem solving ability. Problem solving ability is an individual's ability to effectively solve a problem through their knowledge, skills, and actions to reach a solution (Organisation for Economic Co-opetaion and Development [OECD], 2017).

Concerning the importance of problem-solving skills mastered by students, this is explicitly emphasized in the curriculum, namely as basic competencies that must be developed and integrated into several appropriate materials (Pehkonen, 2007; Titin & Yokhebed, 2018). The basic competency (KD) 3.10, 3.11, and 4.11 Curriculum 2013 in the field of Biology class X related to ecosystem materials and environmental change require students to propose problem-solving ideas. KD 3.10 reads: analyzing information/data from various sources about the ecosystem and all interactions that take place in it, while KD 3.11 reads: analyzing data on environmental changes and the causes and impacts of these changes on human life. KD 4.10 reads: proposing ideas for solving environmental change problems according to the context of environmental problems in their area (Kementerian Pendidikan dan Kebudayaan [Kemdikbud], 2017). Based on the demands of the KD, the teacher should train students' problem-solving skills in various ways. One way to train students' problem-solving skills is through teaching materials. Teaching materials can help to be maximal in learning (Gazali, 2016) and easy to accept lessons (Pratiwi et al., 2014).

The problem that arises is that the teaching materials available for high school students are currently general throughout Indonesia. Leksono et al. (2015) states that the use of teaching materials nationally or similarly causes the local context of an area not to be conveyed in learning in the school environment. There are not many teaching materials that integrate local wisdom and potential possessed by each area where students' study. Whereas contextual teaching materials will be easier for students to understand, this is supported by Parmin and Peniati (2012) which states that teaching materials containing local context content can provide real experience for students so that learning will be contextual and easy to understand to increase the efficiency of activities. learning (Rahmatih et al., 2017). The teaching materials used in schools currently do not contain local insightful information that trains problem-solving skills. Therefore, this research will develop teaching materials based on local wisdom and practice problem-solving skills.

The local wisdom of an area has its peculiarities. Many of this local wisdom contain environmental conservation values. The knowledge gained by students about the environment will be meaningful so that it can be applied in everyday life (Apriana, 2012). Local wisdom-based teaching materials are very important and indispensable in the world of education. Local wisdom-based education provides students with knowledge, skills, and attitudes. And students can have a good insight into the surrounding environment.

Two local pearls of wisdom that were adopted and integrated into the teaching materials in this study were the local wisdom of the city of Binjai whose residents still apply the concept of local wisdom in managing agriculture and the local wisdom of Tumpek Wariga adopted by Hindus in Bali related to environmental conservation and reforestation. These two local pearls of wisdom are integrated with ecosystem materials and environmental changes as required in the revised 2013 Curriculum accompanied by problem-solving exercises. The problem-solving skills that are trained refer to Johnson and Johnson (Sanjaya, 2010) which include: formulating problems, diagnosing problems, formulating hypotheses, determining strategies, and evaluating.

Research related to the development of teaching materials as learning resources has previously been investigated by Setyowati (2018) by utilizing the biodiversity of the Tesso Nilo National Park in Riau Province on students' problem-solving abilities and the results show that the teaching materials developed can improve problem-solving abilities. The teaching materials developed must be innovative and provide opportunities for teachers to innovate in including the local context of the local culture so that learning still meets the standards set with local nuances (Leksono et al., 2015). This is supported by the opinion of Situmorang (2016) which states that the many potentials and local wisdom that are internalized in biology learning affect educators to be able to develop biology as a tool in presenting biological material that is suitable for everyday life. Raising the

local context in learning will increase students' understanding of the material being taught and support the formation of knowledge, attitudes, and skills in making decisions and solving problems (Subiantoro et al., 2013).

Based on the background, this study developed teaching materials based on local wisdom of agriculture in Binjai and local wisdom of Tumpek Wariga in Bali and analyzed their impact on improving the problem-solving abilities of students of class X SMA.

Method

The research method used in this study is a development method that refers to ADDIE (Analyze, Design, Develop, Implement and Evaluate) from Branch (2009). At the analysis stage, data were collected from farmers in Binjai and the community implementing the Tumpek Wariga ceremony in Bali. Sampling was carried out by a purposive sampling method with consideration of qualified knowledge of the problems studied, to be able to provide the expected information. At the implementation stage, teaching materials were tested in schools using a quasi-experimental method with a non-equivalent control group design. The population of this research is the students of class X SMA in one of the schools in Binjai and Bali. Sampling was done by a convenience sampling method, which uses existing samples. The sample was taken in as many as 2 classes in each place, one class as a control class that uses teaching materials commonly used in schools and one class as an experimental class that uses teaching materials based on local wisdom developed, namely teaching materials based on local wisdom of Binjai agriculture and local wisdom. Tumpek Wariga in Bali.

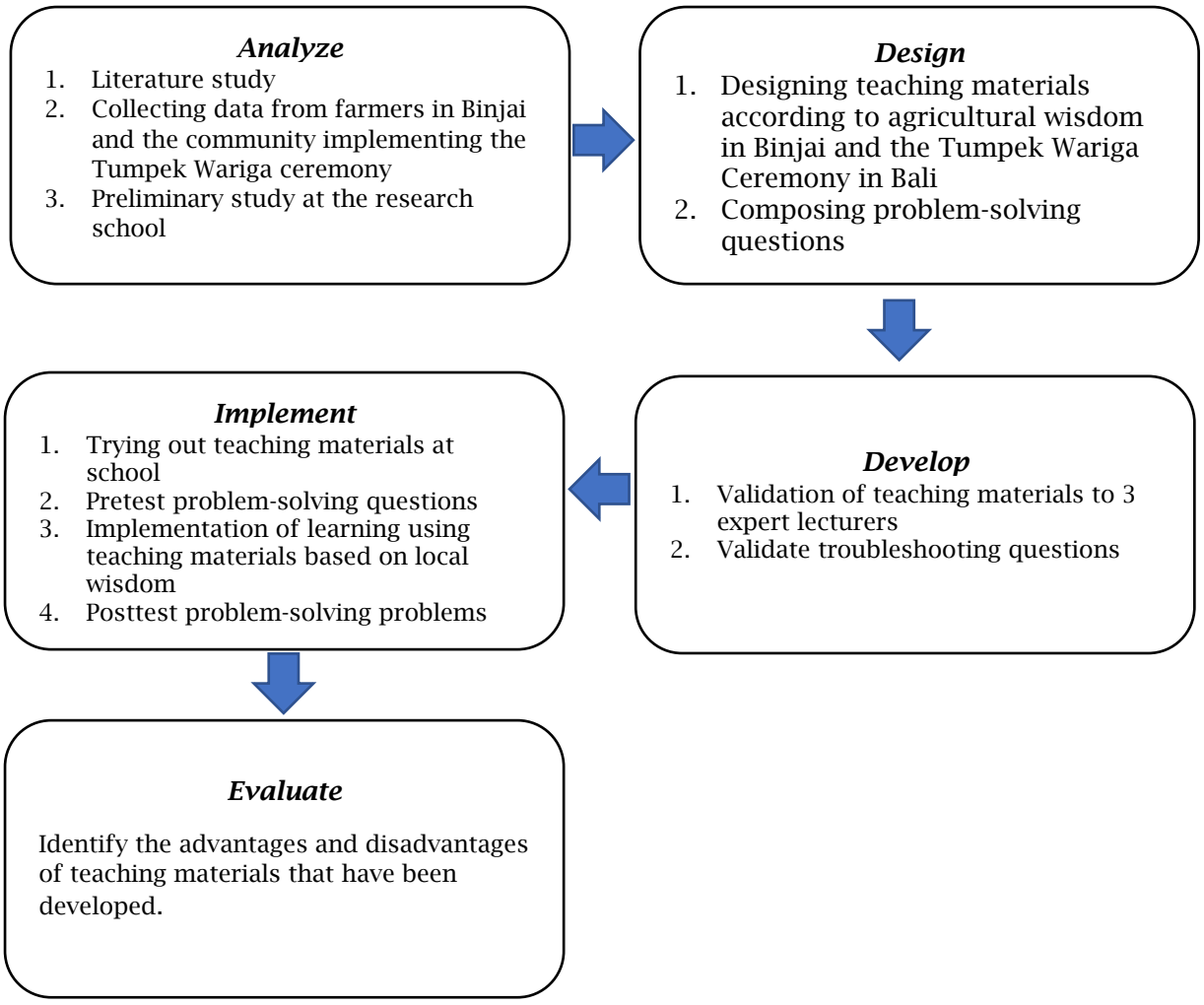

Figure 1. Research flow

Table 1. Interpretation of the percentage range of feasibility test

Presentation range	Interpretation
0% - 25%	Very not feasible
26% - 50%	No feasible
51% - 75%	Feasible
76% - 100%	Very feasible

The number of students involved in the study was 35 people in each class at SMA Binjai and 32 people in each class at SMA Denpasar Bali. The selection of the school as the research site was based on the proximity of the school to agricultural activities in Binjai and proximity to Tumpek Wariga activities as well as a large number of land conversions in Bali. The research was carried out in the even semester of 2018/2019. The flow of the development of teaching materials is depicted in Figure 1.

The instruments used in this study include interview and observation sheets for indigenous peoples, teaching materials feasibility test instruments (Badan Standar Nasional Pendidikan [BSNP], 2014), readability tests (Suhadi, 1994), and problem-solving questions. The instrument was developed through the validation stage by 3 lecturers, while the problem-solving questions were tested on students to calculate the level of difficulty, discriminating power, validity, and reliability. Problem-solving problems related to agricultural teaching materials in Binjai consist of 10 questions with 2 questions each for each problem-solving indicator. The validation results show that the 10 questions can be accepted with a reliability of 0.61 including the sufficient category. While the problem-solving questions related to environmental teaching materials in Bali were based on local wisdom, Tumpak Wariga amounted to 5 questions with 1 question each for each problem-solving indicator with a reliability of 0.71 (high). Problem-solving questions were given through pretest before learning and through posttest after learning.

Table 2. Criteria for the level of readability

Readability level	Criteria
>57%	High
44% ≤ TK ≤ 57%	Medium
TK < 44%	Low

Table 3. Interpretation of N-Gain value

N-gain value	Criteria
N-gain > 0.7	High
0.3 ≤ N-gain ≥ 0.7	Medium
N-gain < 0.3	Low

To see the impact of the developed teaching materials on problem-solving abilities, statistical calculations were carried out using pretest and posttest data. The statistical test step begins with a prerequisite test which includes the normality test with the Shapiro Wilk test and the homogeneity test with Levene's test. Statistical testing was continued by testing the two means using the Mann-Whitney U test. To see the magnitude of the increase in problem-solving abilities as a result of the impact of teaching materials, N-gain (Normalized-gain) was calculated (Hake, 2002). The criteria for the feasibility test, readability test, and N-gain are listed in Tables 1, 2, and 3.

Results and Discussion

The results and discussion are presented according to the ADDIE stages (Analyze, Design, Develop, Implement and Evaluate). In the analysis stage, as shown in Figure 1, data were collected in the form of an analysis of local agricultural wisdom in Binjai and environmental changes associated with the Tumpek Wariga ceremony in Bali as well as a preliminary study to schools to analyze students, the results are listed in Table 4.

Findings of the local wisdom of Binjai Agriculture and the Tumpek Wariga Ceremony obtained through interviews with farmers in Binjai and the community implementing Tumpek Wariga in Bali became a reference in developing teaching materials. These findings are integrated into the appropriate material in the 2013 Curriculum in the field of Biology. Analysis of students through a preliminary study found the fact that students know about local wisdom in their area but the teacher has not integrated the local wisdom as a learning resource. The same finding was found in the research; namely, teachers have not utilized local wisdom and potential in their area as learning resources (Anggraeni et al., 2021; Ivana et al., 2021).

Table 4. Findings at the Analysis stage

Aspect	Finding
Farm local wisdom in Binjai	Traditional agriculture in Binjai still adheres to the procedures that have been passed down from generation to generation. The management of these fields includes planting, traditional irrigation systems, pest eradication (menukal), bombing to repel rats. fertilizing with manure, until the harvesting process (threshing rice), closing the harvest, and ending with wages and chipping rice (a thanksgiving ceremony. The findings of traditional agriculture in Binjai are integrated with Ecosystem materials and environmental changes in the teaching materials developed
Changes in the Balinese environment related to the Tumpek Wariga ceremony	The analysis of the Tumpek Wariga local wisdom includes the purpose and time of the ceremony, the means of the ceremony, the steps for the Tumpek Wariga ceremony, and the values contained in the Tumpek Wariga ceremony. Information on the local wisdom of Tumpek Wariga along with information on environmental changes in Bali is integrated into the Environmental Change material in the developed teaching materials.
Analysis of students in the school where research (preliminary study)	Students in Binjai who are close to agricultural activities know about agricultural management in Binjai, but the teacher has not introduced rice fields in Binjai as a learning resource when studying Ecosystems. Students in Denpasar Bali where the research was conducted generally understand the Tumpek Wariga ceremony, because this ceremony is one of the traditional religious ceremonies, but learning at school has not linked it to local wisdom in Bali.

In fact, including local wisdom or potential in learning or teaching materials provides many advantages, as stated by Kumala and Sulistyowati (2016) that using local wisdom-based teaching materials can present the knowledge and values contained in it to improve student activity and learning outcomes. student. Besides that, teaching materials based on local wisdom can equip students so that the environment is sustainable and students' character grows so that they will become citizens who are wise to the environment and society (Yolida & Marpaung, 2017). Another benefit of learning with local wisdom-oriented teaching materials is contextual so that the material is easily understood by students.

At the design stage, the design and preparation of teaching materials are carried out under the demands of the revised 2013 Curriculum at KD 3.10, 3.11, and 4.11. The design activity begins with making a macrostructure of the material to be poured into teaching materials, determining the characteristics of teaching materials, and integrating local wisdom based on data collected in the field. To be easy to understand and interesting to read, teaching materials are equipped with colorful pictures. Suciyati and Adian (2018) state that teaching materials must attract students' interest in learning, seen from the model format used such as letter selection, size, image display, and material display. Figures 2 are examples of displaying teaching materials based on agricultural wisdom in Binjai (Figure 2a) and environmental changes concerning the Tumpek Wariga ceremony in Bali (Figure 2b). Examples of problem-solving problems are shown in Figure 3a for agricultural problems in Binjai, and Figure 3b for the Tumpek Wariga batch in Bali.

At the development stage, validation of teaching materials is carried out which includes a feasibility test and readability test by 3 lecturers. Meanwhile, the problem-solving questions were tested on students who were not research subjects. Before being validated, the teaching materials have been improved 2-3 times. The results of the feasibility test in terms of material and graphics are listed in Table 5.

Table 5 shows that teaching materials based on local agricultural wisdom in Binjai and Tumpek Wariga in Bali obtained an average percentage of feasibility values of 83.64% and 88.10%, both of which were included in the very feasible category. This shows that the development of teaching materials based on local wisdom of agriculture in Binjai and based on local wisdom of Tumpek Wariga in Bali is following the criteria of the Department of National Education (2008), namely having excellent coverage, accuracy, and up-to-date material following the learning objectives, improving problem-solving abilities.

(a) (b)

Figure 2. Examples of content for teaching materials agricultural with local wisdom (a) Binjai and (b) Tumpek wariga in Bali

This is supported by Sadjati (2012) which states that the teaching materials developed are usually specific, meaning that the teaching materials are only designed to achieve certain goals and specific audiences. The teaching materials developed in this study aim to train students' problem-solving skills. The existence of a combination of pictures, local examples, local facts found in teaching materials based on local wisdom becomes additional knowledge for students in enriching insight into the basic competencies that must be mastered (Faridah, 2019).

In addition to the feasibility test in terms of material and graphics, a readability test was also carried out using a gap test. The gap test is useful for testing the difficulty, ease of reading materials, classifying students' reading levels, and knowing the feasibility of discourse according to learning activities. The results of the gap test are listed in Table 6.

(a) (b)

Figure 3. Examples of problem-solving for (a) agricultural problems in Binjai; and (b) the Wariga batch in Bali

Table 5. The results of the feasibility test on agricultural teaching materials in Binjai (I) and the Balinese environment are based on Tumpek Wariga (II)

Assessment aspect	Average (%)		Category	
	I	II	I	II
Feasibility of content	79.69	88.62	Very Feasible	Very Feasible
Feasibility of serving	77.27	84.59	Very Feasible	Very Feasible
Contextual assessment	77.77	91.67	Very Feasible	Very Feasible
Graphic rating	89.70	86.72	Very Feasible	Very Feasible
Feasibility of language	93.75	88.88	Very Feasible	Very Feasible
Total average	83.64	88.10	Very Feasible	Very Feasible

Table 6 shows that the readability test for both teaching materials based on local wisdom is in the high category, which is more than 57% (Suhadi, 1994). This means that local wisdom-based teaching materials that have been developed can be understood by students and can be used independently. As stated by Tomlinson (1998), the use of communicative language in teaching materials causes content to be conveyed to students.

Besides being loaded with local wisdom of agriculture in Binjai and Tumpek Wariga in Bali, teaching materials are also equipped with exercises on problem-solving skills with the context of the problems that occur in agriculture in Binjai and the environment in Bali, to train students to master problem-solving skills.

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The trial of teaching materials begins with a pretest of problem-solving abilities in the experimental and control classes. After that, in the experimental class students were given teaching materials that were developed to be read and studied independently. Students are asked to work on problem-solving practice questions in the teaching materials and the answers are collected. Meanwhile, in the control class, students study teaching materials commonly used in schools. The trial activity ended with a posttest of solving problems similar to those given in the pretest.

The results of the statistical calculation of the students' solving ability pretest data at SMA Binjai using the two-mean test to see whether there was a difference in the average of the control and experimental classes showed that the results of the pretest of the control and experimental classes did not show a significant difference. This means that students' ability to solve problems is the same before the teaching materials are applied. Therefore, Figure 4 only shows the posttest results of the control and experimental classes.

Figure 4 shows that the posttest results of the experimental class' problem-solving abilities are greater in every aspect of problem-solving than in the control class. This is because students in the experimental class were trained to answer problem-solving questions contained in teaching materials based on local agricultural wisdom in Binjai, while those in the control class were not trained. Ulya (2016) states that problem-solving skills cannot be obtained instantly, but must be trained continuously. And indeed, students should be involved in problem-solving exercises so that students can build problem-solving skills that they already have (Adeyemo, 2010). To find out the magnitude of the increase in students' problem-solving abilities, the N-Gain value was calculated. The results of the calculation of N-gain for the control and experimental classes at schools in Binjai are listed in Table 7.

The results of the N-gain calculation show that the control class has increased problem-solving skills in the low category, while the experimental class has increased in the medium category. The distribution of the achievement of increasing problem-solving abilities for each category seen from the N-gain is listed in Figure 5.

Table 6. The results of the gap test on teaching materials

Teaching content	Average percentage of readability (%)	Category
Farm local wisdom in Binjai	77.13	High
The local wisdom of the Tumpek Wariga ceremony in Bali	95.39	High

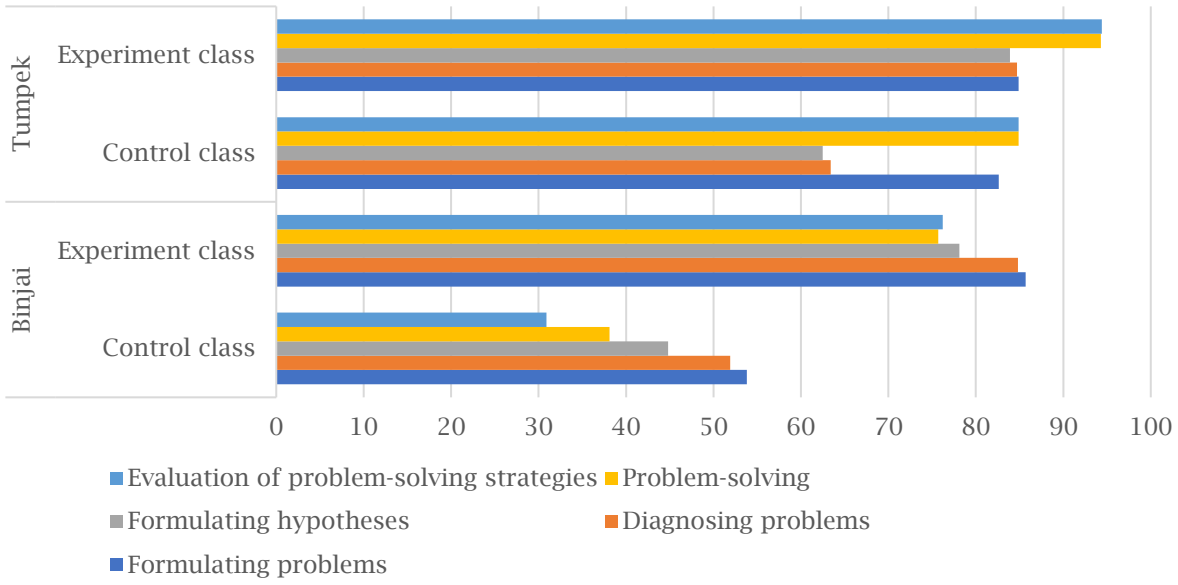

Figure 4. Comparison of the solving ability of control and experimental classes on agricultural teaching materials in Binjai

Figure 5 shows that in the experimental class the increase in problem solving ability is in the medium (71.43%) and high (28.57%) category and none is in a low category, in contrast to the control class, all students experienced an increase in the low category (100%) and no improvement in the medium and high categories. This shows that the use of teaching materials based on local agricultural wisdom in Binjai can improve students' problem-solving abilities. The limited-time for students to study well the teaching materials developed caused the increase in N-gain in the experimental class not to occur optimally, it was still in the medium category.

The results of statistical calculations for pretest data on students' problem-solving abilities at SMA Denpasar Bali using Mann-Whitney-U (because the prerequisite test was not met) showed that there was no significant difference between the control and experimental classes.

This means that the problem-solving abilities of the control and experimental classes before the teaching materials are applied are the same. Figure 4 shows the results of the control and experimental class posttest. Based on Figure 4 the problem-solving ability of the experimental class is greater than the control class. This shows that the Tumpek Wariga local wisdom-based teaching materials that have been developed can improve problem-solving abilities. Searching for information to answer practice questions through books or teaching materials is one way to train students to get problems solving (Tivani & Paidi, 2016).

In contrast to the problem-solving ability of the control class of high school students in Binjai which was low on the posttest (Figure 4), the problem-solving ability of the control class of high school students in Denpasar Bali showed a good score. This is presumably because the local wisdom of Tumpek Wariga presented in the teaching materials is part of a religious ceremony that is known, understood, and implemented by all Balinese people, including high school students who are the subject of research. Meanwhile, local agricultural wisdom in Binjai is only known and implemented by farmers and the surrounding population who are involved in agriculture, so that this local agricultural wisdom does not belong to all the people of Binjai. This affects the knowledge of students in both places on the local wisdom that applies in their respective regions and will ultimately affect the ability of students to solve environmental problems.

To see the magnitude of the increase in the problem-solving ability of control and experimental class students in Denpasar Bali Senior High School, N-Gain was calculated. The results are listed in Table 7.

Table 7. Normalized N-Gain value of Binjai's agricultural problem-solving ability

	Group	Average N-gain	Interpretation
Binjai	Control class	0.05	Low
	Experiment class	0.67	Medium
TUmpek	Control class	0.39	Low
	Experiment class	0.71	High

Based on Table 7, it is known that the increase in problem solving ability in the control class is in the medium category, while the increase in the experimental class is in the high category. The distribution of the achievement of increasing problem-solving abilities for each category seen from the N-gain is listed in Figure 5.

Based on Figure 5, the increase in the problem-solving ability of students in the experimental class is in the high category (52.77%) and moderate (47.22%) and none is in a low category. Meanwhile, in the control class, the increase in problem-solving abilities was in the high (13.89%), medium (44.44%), and low (41.67%) categories. From the results of the distribution of N-gain, it can be concluded that the improvement in problem-solving in the control class is in the medium category and the experimental class is in the high category.

Based on the results of the study, it can be identified that the two teaching materials developed, namely agricultural teaching materials in Binjai and the Balinese Environment based on Tumpek Wariga local wisdom can improve students' problem-solving abilities. Environmental facts presented in teaching materials help students achieve problem-solving abilities. Students can relate the environmental concepts and facts they read to teaching materials so that they can determine strategies to solve problems. This is following the opinion of Achyani et al. (2010) that the application of examples of facts found in the environment around students will help and facilitate students in understanding concepts.

The increase in students' problem-solving abilities is also caused by the fact that local wisdom-based teaching materials contain practice problem-solving questions that are presented in stages and detail with questions that lead to the problem-solving component. Giving practice problems solving problems that are repeated and contextual causes students to be more trained in solving problems. This is supported by Toharudin (2015) that repeated exercises cause students to be trained in the ability to observe, evaluate, argue and communicate and learn to be more active. The ability to solve problems is closely related to the ability to observe, evaluate, argue and communicate. And one way to practice problem-solving skills is to answer practice questions and examine information, including through teaching materials (Tivani & Paidi, 2016). The problems presented in the form of discourse in teaching materials are used as a starting point to improve students' solving abilities and integrate knowledge (Inel et al., 2010) and problem-solving can improve scientific operational abilities and students' attitudes towards solving a problem (Mukhopadhyay, 2013). This is supported by Fitri (2011) which states that problem-solving-based learning can improve students' thinking skills, especially critical thinking and problem-solving.

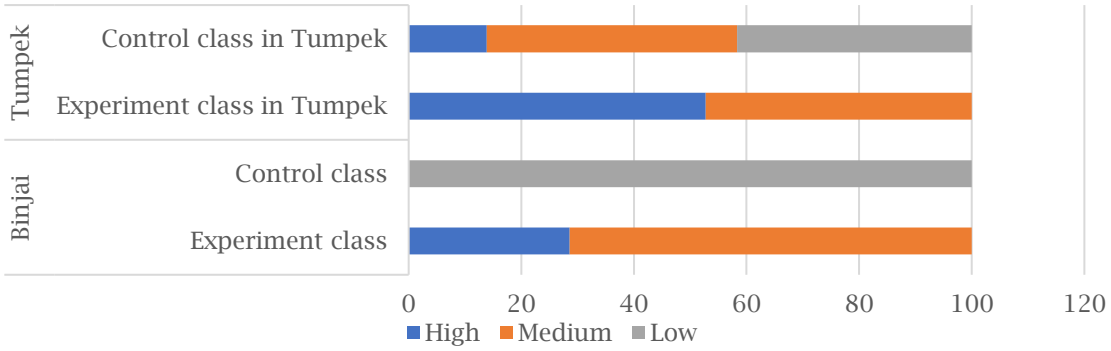

Figure 5. Normalized N-Gain value of problem-solving ability

Problem-solving ability is a HOTS (High Order Thinking Skill) that is influenced by internal and external factors. Internal factors that affect problem-solving abilities are student interest and motivation (Lazarides & Ittel, 2013; Sumantri & Whardani, 2017; Tambunan, 2018; von Maurice et al., 2014). In this study, student interest was facilitated through teaching materials equipped with a combination of colorful pictures, local examples, and local facts which were expected to motivate students to study teaching materials more deeply. While external factors that affect students' ability to solve problems are the approach and implementation of learning (Al-Agili et al., 2012; Sa'ad et al., 2014). In this study, local wisdom-based teaching materials developed are one aspect of external factors that can affect problem-solving abilities.

Conclusion

Based on the results of the study, it can be concluded that teaching materials based on local wisdom of agriculture in Binjai and the Balinese environment based on local wisdom of Tumpek Wariga are in the very feasible category from the feasibility aspect and are included in the high category from the readability aspect. In addition, the two local wisdom-based teaching materials can improve problem-solving skills in the medium category for students who use Balinese environmental teaching materials based on local agricultural wisdom in Binjai and high categories for students using Balinese environmental teaching materials based on Tumpek Wariga local wisdom.

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