

# Implementation of Logic and Set Textbook with Ethnomathematics Content Oriented towards Higher-Order Thinking Skills

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## ABSTRACT

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Higher-order thinking skills are skills that are an important aspect of teaching and learning mathematics. Mathematics and culture have a very close relationship, so the development and application of mathematical concepts in the learning process must be based on situations of daily life or local culture. In 2021, Researchers have developed a textbook of Logic and Set containing ethnomathematics oriented toward higher-order thinking skills. The textbook meets the 'Very Good' category on the validity test after being assessed by five experts. This year, the research focuses on the implementation and evaluation of the textbook in Logic and Set courses. The purpose of this research was to describe the feasibility level of the textbook. ADDIE's design research was used in this development research. The trial subjects in this research were 140 students in the Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Mataram who were taking the Logic and Set courses in the 2021/2022 academic year. Data collection techniques in this research were practicality questionnaires and higher-order thinking skills tests. The results of the data analysis for the practicality assessment of the textbook showed an average score of 81.44, which met the practical classification. Then the average value of the students in the final value of the Logic and Set courses is 81.90. In addition, the percentage of students who achieved a score of 75 was 76% or 106 students. Therefore, it can be concluded that the textbook meets the effective criteria.



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## A. INTRODUCTION

Higher-order thinking skills are one of the most needed skills in the 21<sup>st</sup> century. The practice of higher-order thinking skills is part of the general skills that must be instilled in all subjects, one of which is mathematics education (Misri et al., 2021). Higher-order thinking skills are not just an understanding of mathematical concepts; they are obtained from the process of constructing mathematical concepts, and are related to how these concepts are used (Djidu et al., 2021). Higher-order thinking skills play an important role in applying, connecting, or sequentially manipulating previous knowledge to solve new problems effectively (Retnawati et al., 2018). The benefits of teaching and assessing higher-order thinking skills regularly in learning mathematics include being able to find out the

development of thinking processes and improving students' thinking skills (Brookhart, 2010; Tambunan, 2019). Research shows that students with high levels of higher-order thinking skills tend to have a high GPA as well (Tanujaya et al., 2017).

Higher-order thinking skills are an important aspect of teaching and learning, especially in higher education institutions (Akhsani & Purwanto, 2015; Pratama & Retnawati, 2018; Retnawati et al., 2018; Tanujaya et al., 2017). Integrating higher-order thinking skills in learning and assessment on an ongoing basis can provide distinct benefits for students, namely increasing their understanding, knowledge, learning outcomes, and motivation (Brookhart, 2010; Nitko & Brookhart, 2007). Logic and Set is a compulsory subject in the Department of Mathematics Education that studies logic, in this case it includes the ability to think analytically, logically, and axiomatically as well as proof techniques and the basics of set theory and the relationship between the two. Therefore, learning Logic and Set requires higher-order thinking skills. Higher-order thinking skills in learning mathematics can be trained using textbook (Pratama & Retnawati, 2018).

In previous research (Subarinah et al., 2022), it was found that students' high-order thinking skills in logic and set courses are still relatively low. Subarinah et al. (2021) have developed a textbook of Logic and Set contain ethnomathematics content oriented towards higher-order thinking skills. The textbook consists of five chapters, namely (1) Logic, (2) Set Theory I, (3) Set Theory II, (4) Logic and Set Theory, and (5) Higher Level Thinking in Mathematics Olympiads. The textbook was developed with ethnomathematics content, the culture of the Sasak tribe in Lombok, Nusa Tenggara Barat, which includes food, drink, dance, games, and traditional musical instruments as well as local cultural life. The cultural content of the Sasak tribe is integrated into the material, sample questions, and practice questions developed in the textbook.

In 2021, research has been carried out on the development phase, namely by developing textbook products according to the design and validating the textbook with five experts. Validation by experts is needed as an evaluator of the language, content, and presentation of book that has been developed. The results of the assessment showed that the Ethnomathematics-oriented Logic and Set textbook which was oriented towards higher-order thinking skills met the "Very Good" category in the validity test after being assessed by experts (Subarinah et al., 2022). So that the textbook was suitable for use as a learning resource.

In 2022, research will focus on the implementation and evaluation of the textbook in Logic and Set courses for the even semester 2021/2022 academic year. This research will focus on the practicality and effectiveness of Logic and Set textbook with ethnomathematics content to improve higher-order thinking skills. Based on this, the purpose of this research was to describe the feasibility of Logic and Set textbook that contain ethnomathematics content oriented to students' higher-order thinking skills.

In previous research Subarinah et al. (2022), it was found that the logic and set books used by students of the mathematics education study program at the University of Mataram still did not apply the local cultural context. In addition, the existing questions do not lead to higher-order thinking skills. In fact, students' high-order thinking skills in logic and set courses are still relatively low. Several studies have shown that learning that contains

ethnomathematics can improve students' higher-order thinking skills such as problem-solving skills Abdullah et al. (2015); Aprilyani & Hakim (2020); Cahyadi et al. (2020); Geni et al. (2017); Prabawa & Zaenuri (2017); Utami et al. (2018), critical thinking skills Martyanti & Suhartini (2018); Novitasari et al. (2022); Sarwoedi et al. (2019); Sumiyati et al. (2018); Wahyuni & Koesdyantho (2018), and the ability to think creatively (Amalia, 2018; Amalia, Purwaningsih, & Fasha, 2021; Sariningsih & Kadarisma, 2016; Supriadi, 2017).

The development of ethnomathematics in mathematics learning is a trend that needs to be developed, especially in learning that promotes local culture. Research on the development of ethnomathematics learning modules is currently dominated at the school level, both elementary school (Anggraeni et al. (2020); Febriyanti & Ain (2021); Mardiah et al. (2018); Triwahyuningtyas et al. (2022), junior high school Arif et al. (2019); Nurmaya (2021); Putri (2022); Sholeh et al. (2021); Woli et al. (2021), and high school (Choirudin et al., 2020a; Fitriyah et al., 2018; Misri et al., 2021). Therefore, in this research a college level textbook was developed with ethnomathematics nuances by highlighting the local culture of the Sasak tribe.

### **High-Order Thinking skills**

Brookhart (2010) defines higher-order thinking skills as knowledge transfer, critical thinking, and problem solving. One of the learning goals is the transfer of knowledge, where students are required not only to remember but also to understand and be able to use what they have learned (Anderson et al., 2001). In this context "able to think" means students can apply the knowledge and skills they develop during learning to new contexts (Brookhart, 2010; Nitko & Brookhart, 2007). "New" here means an application that students haven't thought of before. Higher-order thinking skills are understood as a person's ability to connect what they have previously learned with other elements outside the area that has been taught to solve problems.

Critical thinking is reflective thinking that focuses on deciding what to believe or do (Norris & Ennis, 1989). In line with this, Zoller (2000) adds that critical thinking is reflective thinking applied rationally and logically to determine what is believed and accepted. Critical thinking categories include reasoning and proving, questioning and investigating, observing and describing, comparing and connecting, discovering complexity, and developing various points of view (Barahal, 2008; Davies & Barnett, 2015). In this context, "able to think" means students can make wise decisions or generate reasoned criticism (Brookhart, 2010; Nitko & Brookhart, 2007). Based on this, the learning objectives are focused on equipping students to be able to reason, reflect, and make the right decisions. Higher-order thinking means that students can reason, reflect, and make the right decisions.

Bransford and Stein say that in the context of learning mathematics, problem solving is necessary for critical thinking, creative thinking, and effective communication (1984). Problem solving as a higher-order thinking skills means that learning objectives must facilitate students' ability to identify and solve problems in everyday life and school assignments (Brookhart, 2010). Problems in everyday life can mean new problems that define themselves and require something new as a solution. The problem is said to be a problem if the solution to the problem cannot be fulfilled by only using a memorized solution (Brookhart, 2010). This is expanded by the definition of problem solving as a non-automatic/non-routine

strategy needed to achieve a goal (Nitko & Brookhart, 2007). Problem-solving questions can be in the form of closed questions, which are a set of math problems designed to get repeated practice with the completion of certain algorithms, or they can also be open-ended questions, which are questions that can have many correct solutions or several ways to the same solution, or they can be an original question whose answer is unknown (Brookhart, 2010). In this research, higher-order thinking skills were focused on students' ability to solve everyday problems related to mathematical Logic and Set material.

Higher-order thinking skills are also associated with the cognitive level of Bloom's Taxonomy, namely analyzing, evaluating, and creating (Anderson et al., 2001; Brookhart, 2010; Retnawati et al., 2018; Thomas & Thorne, 2008). Anderson and Krathwohl (2001) explain that analyzing is the ability to sort a given material or component into several small parts and determine the relationship between the parts and between each part and the overall structure. This aspect can be seen in the ability to distinguish relevant and irrelevant information related to problems and the ability to describe appropriate procedures for solving problems.

Evaluating is defined as making a decision based on criteria (Anderson et al., 2001). This aspect can be measured by the ability to assess the truth of a statement, assumption, or mathematical process and the ability to interpret solutions to a problem. The last aspect, namely creating, involves the process of assembling elements into a coherent or functional unit (Anderson et al., 2001). This aspect can be measured by the ability to develop conjectures or patterns, draw conclusions based on data, and modify data to fit the criteria. In this research, the problems used to measure students' higher-order thinking skills are at the level of analyzing and evaluating.

### **Ethnomatematics Textbook**

In the Indonesian Dictionary, a book is defined as a sheet of paper that is bound, contains writing or is blank, while teaching is defined as giving instructions to people so that they are known. Based on this understanding, it can be concluded that a textbook is a book that contains a collection of material from a particular branch of knowledge, in this case mathematics, that is compiled comprehensively with the intention of explaining it. Mathematics textbook is developed to meet the needs of educators, usually in educational institutions. Arifin and Kusrianto (2009) mention the characteristics of textbook, including: arousing reader interest; being written and designed for student use; being designed for their own environment; being based on competence; being compiled based on student needs and the final competency to be achieved; focusing on providing opportunities for students to practice; accommodating student learning difficulties; always providing summaries; having a communicative writing style; having a density based on student needs; being packaged and used in the learning process; having a mechanism to collect feedback from students; and describing how to study a textbook.

Human civilization is inseparable from the development of culture and mathematics (Sardjiyo & Pannen, 2005). Even so, because of the different ways to get it, many people have doubts that in fact culture cannot be separated from mathematical activities, but is not considered separately or as a way of giving way to the development of mathematics at this time (Muhtadi et al., 2017). This quest is the study called ethnomathematics.

Ethnomatematics is mathematics that is applied by certain cultural groups, groups of workers/peasants, children of certain social classes, professional classes, and so on (D'Ambrosio, 1999; Gerdes, 1994). Ethnomatematics is a form of mathematics that is influenced by culture (Risdiyanti & Prahmana, 2018a, 2018b). Ethnomatematics is an approach to learning mathematics that is based on local culture (Abi, 2016; Marsigit et al., 2018; Pratiwi & Pujiastuti, 2020). Culture in this context has a broad and unique perspective and is closely related to the customs of its people, for example: gardening, playing, creating and solving problems, how to dress, and so on (Muhtadi et al., 2017).

Mathematics and culture have a very close relationship, so the development and application of mathematical concepts in the learning process must be based on the problem situations of everyday life or local culture. By applying ethnomatematics to learning mathematics, students are trained to be able to solve everyday problems related to mathematics (Risdiyanti & Prahmana, 2018a, 2018b). One way of applying ethnomatematics to learning mathematics is by developing ethnomatematics-based textbook.

## B. METHODS

This research is a development research using design research by ADDIE (Analysis, Design, Development, Implementation, and Evaluation) (Branch, 2009). In the Analysis phase, several things were carried out, like curriculum analysis, student characteristics analysis, local culture analysis, indicators of higher-order thinking analysis, and the resources needed analysis. In the Design phase, a draft textbook is made to be developed, then the researcher collects materials for development and arranges research instruments. In the Development phase, textbooks are developed based on the previous design and in this phase, textbook validation and revision are carried out. In the Implement phase, implementation was carried out in the field. The last phase is Evaluate, the data obtained in the previous phase is processed to determine the feasibility of the textbook, as shown in Figure 1.

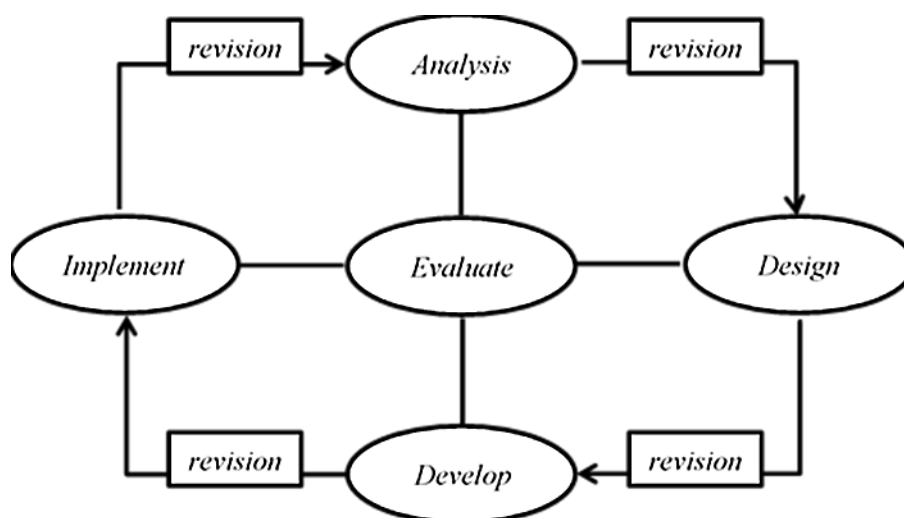


Figure 1. ADDIE Procedure

The product developed in this research is an Ethnomatematics Textbook of Logic and Set to improve higher-order thinking skills. This research is a follow-up research from

development research conducted in 2021 (Subarinah et al., 2022). This year's research is entering an evaluation phase, in which a process is carried out to determine the feasibility of the textbook being developed. Textbook is said to be appropriate if it meets practical and effective criteria. Practicality and effectiveness based on criteria (Nieveen, 1999) are: 1) practical, meaning that the product being developed is useful and easy for users to use; and 2) effective, meaning that the developed product has succeeded in achieving its development goals. The test subjects in this research were students of the Department of Mathematics Education at Faculty of Teacher Training and Education, Universitas Mataram who were taking a Logic and Set courses in semester 2 of the 2021/2022 academic year. There are 140 students from 5 classes. The number of students in each class is 28, 28, 29, 30, and 25 students respectively.

Data collection techniques in this research were in the form of test and non-test techniques. In the non-test technique, the researcher uses a practicality questionnaire that is filled out by students. The practicality questionnaire used contains 20 statements related to the usefulness and ease of use of the textbook. The questionnaire uses a Likert scale of 5, namely: (1) strongly agree; (2) agree; (3) neutral; (4) disagree; and (5) strongly disagree. The table below is a classification of the practical quality of learning media based on the formula for determining the classification interval from Widoyoko (Widoyoko, 2016). The data obtained from the Practicality Questionnaire is used to determine the practicality of the textbook being developed. The developed textbook meets the practical criteria if the average results of the students' practicality assessment score on the textbook are in the practical minimum classification ( $X > 68$ ) as can be seen in Table 1.

**Table 1.** The Practical Quality Classification of Textbook Based on Student Assessments

Score	Classification
$X > 84$	Very Practical
$68 < X \leq 84$	Practical
$52 < X \leq 68$	Quite Practical
$36 < X \leq 52$	Less Practical
$X \leq 36$	Not Practical

In the test technique, the researcher uses an instrument in the form of a Higher-Order Thinking Skills Test. The Higher-Order Thinking Skills Test was developed based on the cognitive level of Bloom's Taxonomy, namely analyzing and evaluating. Students took the test twice during the lecture period, once in the middle and once at the final of the semester. The first test contains four item questions, and the second test contains five item questions, all of which are in the form of descriptions. The scores obtained from the Higher-Order Thinking Skills Test are converted into values ranging from 0 to 100. The results of the tests at the mid and final of the semester are averaged to become the final score used to determine the effectiveness of the textbook. Textbook is said to meet the criteria of being effective if at least 75% of the overall students achieve a score of 75. Several items on the Higher-Order Thinking Skills Test can be seen in Table 2.

**Table 2.** Several Items on The Test Instrument Assess Higher-Order Thinking Skills

Aspect	Test 1	Test 2
Analyze	<p>It is known that data from 400 students of Department of Mathematics Education. 50% of students like to eat <i>pelecing kangkung</i>. 72.5% of students like to eat <i>ayam taliwang</i>. 65% of students like to eat <i>bebalung</i>. 37.5% of students like to eat <i>pelecing kangkung</i> and <i>ayam taliwang</i>. 25% of students like to eat <i>pelecing kangkung</i> and <i>bebalung</i>. 50% of students like to eat <i>ayam taliwang</i> and <i>bebalung</i>. 7.5% of students do not like to eat all three. From the information above, make a Venn diagram to see how many students:</p> <ol style="list-style-type: none"> <li>like to eat only one dish.</li> <li>like to eat only two dishes.</li> <li>likes to eat at least one dish out of the three.</li> </ol> <p>(Explain your answers)</p>	<p>A class consists of 50 students. Among them, 25 students liked the <i>gendang beleq</i>, 20 students liked <i>pelelet</i>, 20 students liked <i>gambo</i>, and 10 people liked all three.</p> <p>From the information above, make a Venn diagram to find the number of students who like at least one of the three musical instruments.</p> <p>(Explain your answers)</p>
Evaluate	<p>Suppose <math>P = \{1,2,3, \dots\}</math>. Define relation <math>R</math> on <math>P</math> as follows:</p> $R_1 : x > y$ $R_2 : x + y = 10$ $R_3 : x + 4y = 10$ <p>Based on the three relations above, each check whether the relationship is:</p> <ol style="list-style-type: none"> <li>Reflective?</li> <li>Symmetry?</li> <li>Transitive?</li> <li>Antisymmetry?</li> </ol> <p>(Explain your answers)</p>	<p>Given the following premises.</p> <p>P1: Every student is human.</p> <p>P2: Some people from NTB are also students.</p> <p>Based on the two premises above, determine the validity of the statements below using the Venn Diagram.</p> <ol style="list-style-type: none"> <li>K1: There are students who are also human beings as well as NTB people.</li> <li>K2: Some humans are NTB people.</li> <li>K3: There are students who are not from NTB.</li> </ol> <p>(Explain your answers)</p>

### C. RESULT AND DISCUSSION

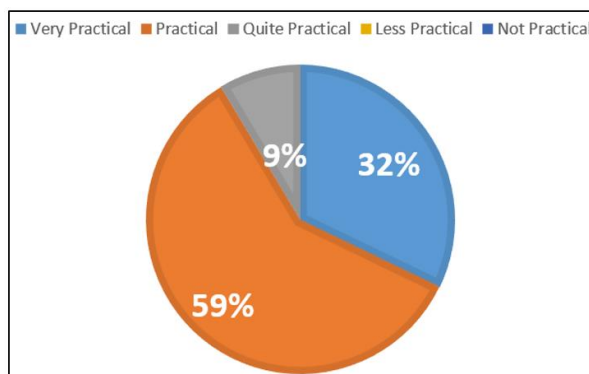
The product developed in this research is a Logic and Set textbook containing ethnomathematics to improve higher-order thinking skills. This textbook is designed for students studying mathematics education who enroll in Logic and Set courses. The following will describe the results obtained based on a practicality questionnaire filled out by students and a high-level ability test. Based on these findings, the product's feasibility in terms of practicality and effectiveness can be determined. The data to determine the practicality of the textbook was obtained from the Practicality Questionnaire. The questionnaire was filled out by mathematics education students. Here are the results obtained, as shown in Table 3.

**Table 3.** The Textbook's Practicality Based on Student Assessments

No	Information	Result
1	Items Number	20
2	Maximum Score	100
3	Minimum Score	20
4	Average Score	81.44
5	Classification	Practical

Based on the data above, it can be seen that the results of the analysis of the practicality assessment data from students show an average score of 81.44, which fulfills the practical

classification. It can be said that the Textbook of Logic and Set fulfills the practical criteria. The details of the percentage of students based on each practicality classification can be seen in Figure 2.



**Figure 2.** Practicality Classification Percentage

Based on the diagram above, it can be said that there are no students who conclude that the textbook is "less practical" or "not practical". As many as 12 students (9%) concluded that the textbook was "quite practical". The largest percentage of "practical" conclusions, namely as many as 83 students (59%), and as many as 45 students (32%) resulted in "very practical". Furthermore, one of the eligibility criteria for the Textbook of Logic and Set is that it is effective. The textbook is said to be effective if at least 75% of the total students score 75. The following is the result of the average student scores in the final grades of Logic and Set courses after using the Textbook for one semester, as shown in Table 4.

**Table 4.** The Final Logic and Set's Average Value Data

No	Information	Result
1	Students Number	140
2	Average of Mid Semester Test Score	80.46
3	Average of End Semester Test Score	83.34
4	Average of Final Grade	81.90
5	Students Number Reaching Score 75	106
6	Completeness Percentage	76%

Based on Table 4 above, it can be seen that there is an increase in students' higher-order thinking skills based on the average midterm and final semester test scores. Then the average student score in the final grade of Logic and Set was 81.90. In addition, the percentage of students who scored 75 was 76% or 106 students. Therefore, it can be concluded that the Textbook of Logic and Set meets the criteria of being effective.

Furthermore, there was an increase in students' abilities to complete tests of higher-order thinking skills in the types of analysis and evaluation questions. The maximum score per question (n) in Test 1 type of analysis question is 25; the type of evaluation question is 20. Then, on Test 2, the maximum score per question for analysis questions is 20; for evaluation questions, it is 20. Table 5 below shows the percentage of the average score (x) on the types of analysis and evaluation questions in Test 1 and Test 2, as shown in Table 5.



**Table 5.** Data on Improving Student Abilities in The Analysis and Evaluation Questions Types

Questions Types	Test 1		Test 2	
	Average Score (x)	Percentage (x/n)	Average Score (x)	Percentage (x/n)
Analysis	19.76 (n = 25)	79%	16.79 (n = 20)	84%
Evaluation	17.30 (n = 20)	86%	17.58 (n = 20)	88%

Based on Table 5, it shows that there is an increase in the percentage of the average student score on the types of analysis and evaluation questions. In the analysis type questions in Test 1, the percentage of the average score divided by the maximum score obtained is 79%, and in Test 2, it is 84%. Then, on the evaluation type questions, the percentage of students with an average student score also increased, namely 86% in Test 1 and 88% in Test 2.

The results above show that the Logic and Set Textbook that was developed met both practical and effective criteria. Textbook meets practical criteria, which means they are useful and simple to use, particularly when it comes to improving higher-order thinking skills. This is because textbook contains ethnomathematics content that helps to improve higher-order thinking skills of students. Ethnomatematics is an approach to learning mathematics that is based on local culture (Abi, 2016; Marsigit et al., 2018; Pratiwi & Pujiastuti, 2020).

Ethnomathematics content in textbooks helps to increase higher-order thinking skills. This is confirmed by several studies that have shown the learning that contains ethnomathematics can improve students' higher-order thinking skills such as problem solving (Abdullah et al., 2015; Aprilyani & Hakim, 2020; Cahyadi et al., 2020; Geni et al., 2017; Irawan et al., 2022; Prabawa & Zaenuri, 2017; Utami et al., 2018), critical thinking (Martyanti & Suhartini, 2018; Novitasari, Febriyanti, & Wulandari, 2022; Sarwoedi, Widada, & Herawaty, 2019; Sumiyati, Netriwati, & Rakhmawati, 2018; Wahyuni & Koesdyantho, 2018), and the ability to think creatively (Amalia, 2018; Amalia, Purwaningsih, & Fasha, 2021; Sariningsih & Kadarisma, 2016; Supriadi, 2017). In addition, several higher-order thinking skills that can be developed include the ability to connect mathematics with ethnomathematics content (Rizka & Mastur, 2014). Then, strategic mathematical abilities also have the potential to be formed through traditional game-based mathematics learning (Susanti et al., 2020).

This is because the local content in textbooks makes it easier for students to be directly involved with the material context. This is in line with what was stated by Fitriyah et al. (2018) and Nurmaya (2021) that ethnomathematics approach can make it easier for students to understand mathematical material. The cultural context of ethnomathematics allows it to be used as a mathematical object in learning (Kusaeri et al., 2019; Yumiati et al., 2023). In addition, an ethnomathematics approach related to student culture in learning helps students more easily understand material that is directly related to their daily culture. The ethnomathematics context in material that students are already familiar with invites students to identify and relate cultural elements in a mathematical material (Abi, 2016; Wahyuni, Tias, & Sani, 2013).

Furthermore, there are several advantages gained from using ethnomathematics in class (Anggraeni et al., 2020; Arif et al., 2019; Choirudin et al., 2020b): (1) learning mathematics becomes more meaningful; (2) improve students' conceptual understanding skills through material that is closely related to everyday life; (3) fostering a sense of love for the motherland by presenting local cultural contexts to students; (4) instill cultural values in

students. In addition, ethnomathematics facilitates students' understanding of mathematical ideas, concepts, and practices that can help solve problems related to their daily activities (Sunandar, 2017). An ethnomathematics approach to learning mathematics needs to be developed, especially learning that promotes local culture (Choirudin et al., 2020a).

#### D. CONCLUSION AND SUGGESTIONS

Textbook of Logic and Set containing ethnomathematics to improve higher-order thinking skills developed in research fulfills practical and effective criteria. The results of the practicality assessment of students showed an average score of 81.44 which met the practical classification. Then, in the final grades of the Logic and Set courses, 76% of students received a score of 75. Where in these lectures students use the Textbook of Logic and Set. It can be said that textbook has benefits and easy to use. In addition, textbook can also support the development of higher-order thinking skills. In further research, additional learning tools that are integrated with Logic and Set textbook can be developed. The forms of learning tools that can be developed include worksheets, presentation slides, learning videos, and others. Learning tools can be focused on various students' abilities, such as problem solving, critical thinking, and creativity.

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