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Ethnomatematics E-Module Development Using Problem-Based Learning to Improve Students' Problem-Solving and Self-Efficacy

Ita Pratiwi Simangunsong[1*]

[1]Departement of Mathematics Education, State University of Medan, Indonesia
[*]Corresponding Author: itapratiwi88@gmail.com

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ABSTRACT

This research develop a digital learning materials that implemented in Ambarita Village, situated near Lake Toba, Samosir Island, that has preserved its indigenous knowledge and traditional customs. The purpose of this study is to analyze the following: 1) the effectiveness, validity, and practicality of the PBL e-module based on Batak Toba Culture (PBL BTC), which was created to improve students' problem-solving skills at SMP Negeri 1 Simanindo; and 2) improving students' problem-solving skills through the developed e-module. The ADDIE is being used in this study. Two results were obtained from the class IX-2 test: 1) The PBL BTC e-module met the requirements of validity, effectiveness, and practicality; 2) Using the PBL BTC e-module improved problem-solving skills as demonstrated by the N-gain value of 0.506 and improved self-efficacy by the N-gain value 0.338 which places it in the "medium" category.

A. INTRODUCTION

All educational levels, including elementary, junior high, high school, and college, require the teaching of mathematics. This is so that kids can be ready for their future employment, as mathematics is a fundamental subject. Problem solving is a very important part of the mathematics curriculum because in the process of learning and solving it, students are able to gain experience using the knowledge and skills they already have to apply to problem solving. Because the knowledge that students have in solving mathematical problems will provide opportunities for students to apply the knowledge they have to understand problems in real life. Solving mathematical problems is one of the mathematical activities that is considered important by teachers at all levels from elementary to high school.

Mason, Burton, and Stacey (2010) outline the several stages of problem solving, which include preparation (entry), execution (attack), and analysis (review). Three activities take place at the entry point: understanding (know), wanting (desire), and introducing (introduce). The three perspectives in an attack chain are try, maybe, and why. Three aspects make up the review process: check, reflect, and extend. There are several indicators at each stage, which are as follows: during the entry phase of the indicator, students can understand the subject and work together to solve problems; during the phase of attack, students can grasp the subject and solve problems related to the problem; during the phase of review, students can assess the efficiency of the problem-solving process.

However, this is considered to be the most difficult part in learning it and for teachers in teaching it. There are many things that can cause low problem-solving abilities, one of which is that teachers appear less able to encourage students to grow their self-confidence. Students' self-confidence in their abilities is very important, so that students can explore their abilities. This feeling of confidence in one's abilities is also called self-efficacy. Self-efficacy is something that is very important because people who have high self-efficacy will work hard in carrying out a task or job and build positive motivation related to the task or work being carried out.

Samsuddin & Retnawati (2022, pp. 18-19) categories the dimensions of self-efficacy, which are Level, Strength, and Generality. The Level is about how confident a person is in handling challenges that get harder. The strength dimension describes a person's unwavering will to use their ability to accomplish a goal in spite

of numerous obstacles and setbacks. Experience is the aspect that affects this dimension. The degree to which self-efficacy is connected to different tasks or domains is known as generality. In the academic sphere, self-efficacy ought to be used broadly when several learning tasks share structural commonalities.

Enhanced learning process quality can lead to an increase in problem solving skills and self-efficacy. Teachers can employ constructivist learning paradigms, including problem-based learning, to maximize learning. The five phases of problem-based learning begin with the teacher exposing the class to a problem scenario and conclude with the presentation and analysis of the students' completed work. If the instructor is prepared and has all the tools needed, the PBL process can be completed. In addition, students need to be aware of the procedure and have organized study groups. Study groups provide students with opportunities to learn and develop interpersonal skills among group members.

To pique students' interest in learning, teachers must use digitally accessible teaching materials that are relevant to the context of the students' life when teaching and learning, especially when it comes to mathematics. Students will be exposed to real-world situations pertaining to issues that they may face in their daily lives, particularly in their local communities, when learning takes place in a cultural context. By doing this, overly theoretical learning will be avoided. According to this study, culture contributes a significant role in math education. Ethnomathematics is the study of mathematics with the help of culture. Culture and mathematics are closely related. Based on his observations of how mathematics has changed over time and the way it has been taught in schools, D'Ambrosio created Ethnomathematics as a remedy. Learning and integrating ideas, strategies, and tactics developed and used by individuals from various ethnic backgrounds is possible through the study of ethnomathematics (Prahmana et al., 2021). Ethnomathematics, in accordance with Borba, is the application of mathematical concepts particular to a culture to the spatial and relational aspects of daily activities (Yeni D. F. et al., 2023).

Electronic Module follows the usual module structure but in digital form. Digital textbooks and modules significantly improve education by giving learners and educators fresh perspectives. The main purpose of creating electronic math learning materials is to enhance HOTS, alternative learning resources, and mathematical literacy for today's learners (Wijaya et al., 2022). Software like Flipbook Maker, Caliber, and Smart Apps Creator (SAC) can be used to create e-modules. The application package file (APK) format is one in which the produced e-module can be formed. Research on ethnomathematics e-module development for junior high school has been done by Utami et al., (2018), Putri et al. (2020), Putra & Haqiqi (2022), Nurfadilah et al., (2023).

B. RESEARCH METHODS

Students from SMP Negeri 1 Simanindo class IX 1 for the development trial and class IX 2 for the implementation served as the research subjects. The learning ability test instrument is used to assess the quality of students' learning outcomes once they have completed following the lesson plan. In this study, the learning capacity exam consisted of essay-style questions that were used to evaluate the participants' problem-solving abilities. This study's object is an electronic module (e-module) about congruence and similarity.

Research and development, or ADDIE, is the type of research that this forms. The following chart explains each phase in the ADDIE process.

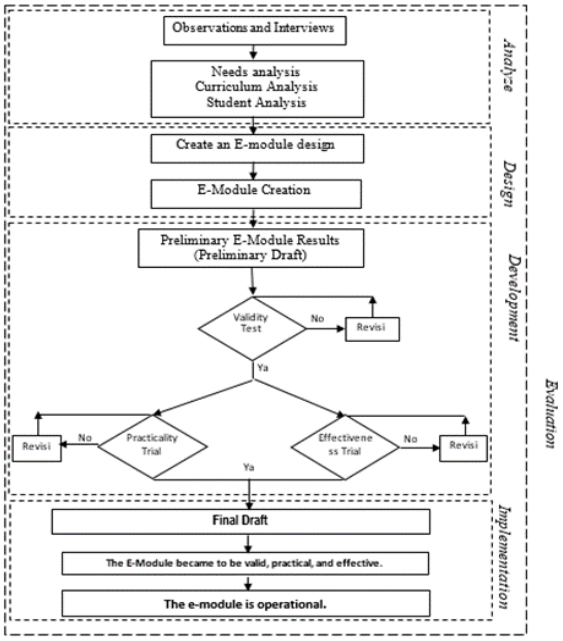

Figure 1. Research Procedure

Instruments for research can be classified into three categories: validity, practicality, and e-module effectiveness. Expert Validation will conduct two types of analysis: media analysis from one validator who is an ICT instructor and content analysis (material) from two validators who are mathematics lecturers. With the criteria according to (Sagala & Widyastuti, 2021), as shown in Table 1.

Table 1. The Criteria of Validity

No	Quality score	Statement quality aspect validity
1	$3{,}26 < \bar{x} \leq 4{,}0$	most valid
2	$2{,}51 < \bar{x} \leq 3{,}26$	valid
3	$1{,}76 < \bar{x} \leq 2{,}51$	adequate
4.	$1{,}00 < \bar{x} \leq 1{,}76$	less

Validity methods for data analysis are carried out if the PBL BTC e-module generated has a minimum level of validity achieved validity level is valid ($2{,}51 \leq Va < 3{,}26$). The process of calculating the learning implementation observation score is as follows:

$$O_k = \frac{\sum_{j=1}^{m} P_i}{m}$$

Information:
O_k= average learning implementation observation score
P_i= average score of learning implementation observations at each meeting
m = number of meetings

After collecting the data, the average total score is established by the results of observations of learning implementation. ($\boldsymbol{O_k}$) with categories as in Table 2.

Table 2. Learning Implementation Criteria

No.	Level of Learning Implementation	Criteria
1.	$1 \leq O_k < 2$	not implemented
2.	$2 \leq O_k < 3$	not well implemented
3.	$3 \leq O_k < 4$	well implemented
4.	$O_k = 4$	very well implemented

The PBL BTC e-module is considered practical if its average learning implementation falls within the 'Well executed' category ($3 \leq Ok < 4$). The BTC PBL e-module fits the effective category in terms of: (1) Classical

achievement of students requirements specifically a minimum of 85% of students who participate in the learning can achieve a score ≥75; (2) 80% of students responded positively to the BTC PBL e-module.

Student self-efficacy gains were determined by analyzing data from student self-efficacy questionnaires. The student self-efficacy tool uses accomplishments that are rated on a Likert scale. For every statement, researchers utilized a grading guideline to get the students' answers. Positive statements are rated as follows: 1 for strongly disagree, 2 for disagree, 3 for agree, and 4 for highly agree. Conversely, table 3 presents the results for negative statements as follows: 4 (strongly disagree), 3 (disagree), 2 (agree), and 1 (strongly agree).

Table 3. Value scale of *self-efficacy*

Positive Statement		**Negative Statement**	
Option	**Score**	**Option**	**Score**
Very Agree	4	Very Agree	1
Agree	3	Agree	2
Disagree	2	Disagree	3
Very disagree	1	Very disagree	4

To determine the range of students' self-efficacy assessments (level of mastery of self-efficacy) the following criteria are used :

Table 4. Tingkat Penguasaan *Self-efficacy*

Interval Score	**Category**
$X \geq \bar{X} + SB_x$	High
$\bar{X} - SB_x < X < \bar{X} + SB_x$	Medium
$X \leq \bar{X} + SB_x$	Low

The growth in students' problem-solving skills and self-efficacy may be analyzed as follows:

$$n - gain = \frac{Score\ postest - score\ pretest}{Score\ ideal - score\ pretest}$$

Table 5. N-Gain Criteria

No.	**Value of N-Gain**	**Level**
1.	$g > 0.7$	high
2.	$0.3 < g \leq 3$	medium
3.	$g \leq 0.3$	low

C. RESULT AND DISCUSSION

The Early Mathematical Ability Test is used to determine the research sample class's equivalence and the student's abilities before the learning process is carried out. T able 1 summarizes the descriptive analysis of student Early Mathematical Ability data on the learning objectives.

3.1 Result

Data analysis and study outcomes from each development step are described here.

3.1. 1 Analyze

Researchers' actual observations from August 2023 indicate that mathematics instruction at SMP Negeri 1 Simanindo is still explanatory. Students receive examples, practice problems, and a clear knowledge of the subject matter's principles and concepts. Teachers that frequently employ the lecture style limit students' chances to learn on their own and expand their own knowledge, which affects the learning objectives of the students.

Additionally, almost all of the student books that are used are general in default, explaining concepts like congruence and similarity without encouraging students to develop their own knowledge. In addition, they don't include non-routine problems like questions that are presented or problems that are connected to the students' cultural surroundings. The problems in student textbooks continue to undermine the growth and improvement of students' self-efficacy and problem-solving skills.

Conforming to the findings of brief interviews, students noted that they found it tricky to comprehend the material in the math textbooks they used, that they thought studying mathematics was less engaging, and that many of them had trouble completing problems. The findings of the students' preliminary exams, which

indicated that their problem-solving skills fell into the low range, confirmed this. Likewise, low student self-efficacy was indicated by the questionnaire's results.

This is predicated on earlier problem solving ability test results, which indicated an average score of 50.45. According to the students' responses to the problem-solving questions, 2 students (6.25%) out of 32 had high abilities, 11 students (34.37%) had medium abilities, 10 students (31.25%) had low abilities, and 9 students (28.13%) had very low abilities. There were 7 students (21.87%) with moderate ability, 7 students (21.87%) with low ability, and 18 students (56.25%) with very low ability in terms of their capacity to plan problem solving. There were 8 pupils (25%) who had low abilities and 24 students (75%) who had extremely low abilities when it came to applying problem solving skills.

There are still a lot of students who believe that mathematics cannot assist students in managing their everyday difficulties, according to the results of the self-efficacy questionnaire that was administered to class IX' students. Students' self-efficacy in mathematics is still low, according to the questionnaire's results. Three hundred and twenty-two SMP Negeri 1 Simanindo class IX students were given a self-efficacy questionnaire consisting of seven items with the options to agree (S) or disagree (TS). Listed here are the seven statement points: (1) I am confident in my ability to solve math problems; (2) I dislike learning math; (3) I persist in trying despite my difficulties; (4) I enjoy searching online for solutions to math problems; (5) If given the option, I would not study mathematics; (6) It is challenging to apply math lessons in real-world situations; and (7) Mathematics can be used to solve problems in everyday life.

Statement number 1 had 18 disagree responses (56.25%), indicating a lack of confidence among pupils in their ability to perform mathematical tasks. Statement number two received 24 agree responses (75%) from the students, indicating that they dislike learning arithmetic. In response to statement number (3), 22 students (68.75%) said that they disagreed. This indicates that pupils are not as engaged in solving mathematical problems and, in the event that they are unable to do so, they frequently duplicate the work of their peers. Statement number four: Twenty students (62.5%) indicated that they disagreed. This indicates that pupils only solve issues based on the teacher's examples; they do not enjoy searching for answers to mathematical puzzles from other sources. 21 students (65.62%) disagreed with statement number 5, indicating that students think mathematics is a very valuable subject to study. There are still more students who believe that mathematics is difficult to apply in everyday life, as seen by the 22 students (68.75%) who responded that they did not agree with statement number 6. Statement number 7: 16 students (50%) responded that they disagreed that mathematics might assist in resolving everyday issues. This indicates that a significant portion of students still hold the belief that mathematics is insufficient to assist in resolving everyday issues. It is clear from the questionnaire's answers that students' self-efficacy in mathematics has to be raised.

Furthermore, a picture of each student's social, economic, and cultural circumstances was gathered through interviews with homeroom teacher. The parents of Simanindo 1 Middle School pupils work in a variety of professions, including farming, entrepreneurship, and public service, based on their socioeconomic background. Parents of pupils generally fall into the middle socioeconomic group. This intermediate group demonstrates that the parents of the pupils are able to give them access to cellphones so they may communicate with them. Fortunately, this guarantees that every student has access to the ethnomathematics e-module.

Based on cultural background, pupils of SMP Negeri 1 Simanindo are predominantly Batak Toba. All students live in the Batak Toba tribe's villages of Ambarita, Tomok, Unjur, and Tuktuk. Several different classifications apply to a variety of tangible manifestations of Batak Toba culture: (1) mentifact: *dalihan na tolu*, *suhi ni ampang na opat*, Batak script, Batak numbers, kinship, *partuturan* (a greeting custom based on genealogy), *turi-turian* (regional stories), Batak songs (*O Tano Batak*), the Batak tribe's life goals (*hamoraon-hagabeon-hasangapon*), *umpasa* (rhymes), *umpama* (garnish), and *lapet* (tradisional food); (2) sociofacts include *tarombo* (genealogy), Batak language, *marsiadapari* (cooperative work), *tortor* Batak (dance), *marria raja* (democracy); (3) artefacts: Ruma Batak or *Ruma Bolon* (traditional house), *tugu* (king's monument), *sigale-gale* (puppet), *ulos* (woven cloth), *sor tali*, *gorga* (calligraphy), *uning-uningan* (Batak drum), *rere* (woven seating/mats), and *tandok* (woven for rice containers). In the meantime, tugu (monuments), Ruma Gorga/Ruma Bolon, ulos, hats, sortali, and lapets are the part of Batak Toba cultures that is covered by this research.

3.1.2 Design

The main components of the Toba Batak culture-based e-module were created and included: the cover, concept map, usage instructions, learning exercises, and reference. The e-module's learning activities includes a pretest, a synopsis of the learning material, sample questions and their answers, and a posttest. The course material is modified to be integrated the problem-based learning (PBL) scenario of instruction. The cover was

designed using the Canva tool, and it was subsequently developed in the Flip Book Professional application. The material's title and a number of graphics pertaining to the material's congruence and similarity within the context of the Toba Batak culture are shown on the cover design.

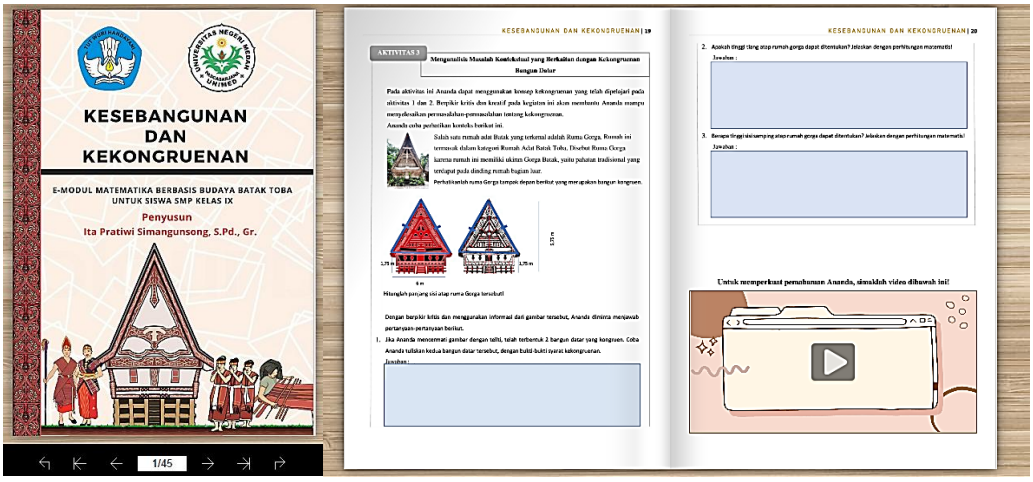

Figure 2. E-module with Batak Toba Context

3.1.3 Development

Five professionals, including two math teacher and three math lecturers, completed the validation process.

Table 6. Results of Material Validation

No	Aspect	Average of each aspect	Criteria
1.	Content competency	3,97	Most Valid
2.	Linguistic component	4	Most valid
3.	Appearance components	3,93	Most Valid
4.	Graphics	4	Most valid
Total Average		**3,97**	**Most Valid**

Table 7. Results of Media Validation

No	Aspect	Average of each aspect	Criteria
1.	Screen design display	4	Most Valid
2.	Ease of use	3.97	Most Valid
3.	Arrangement	4	Most valid
4.	Expediency	3.96	Most Valid
5.	Accuracy	4	Most valid
Total Average		**3,98**	**Most Valid**

The e-module's practicality in trial I did not match the established practical standards. Because of the lack of implementation of learning that occurred during three meetings using the developed e-module, observations of how learning is implemented to measure practicality have not been fulfilled. These observations include: the lack of implementation of learning steps, specifically in activities to solve contextual problems; the lack of implementation in the social system of implementing learning, specifically in the creation of a democratic atmosphere and student activities collaborating in learning; and on the principle of management reaction, specifically in teacher activities that tend to position themselves as learning resources but instead give students the opportunity to words their opinions.

Table 8. Practical Results

Development Trial	Learning Oobservation Average score	Positive Response of Student Average score
First Trial	2,93	93,34
Second Trial	3,33	93,88

Furthermore, the post-test results of students' mathematical solving abilities in trial I, which do not meet the criteria for achieving classical completeness, indicate that there are still indicators of effectiveness that have not been met, meaning that the effectiveness of the e-module does not meet all of the specified effective criteria. However, students' positive responses to the e-module and an increase in their level of self-efficacy were the effectiveness markers that were reached in trial I. The initial trial's outcomes served as a guide and source of feedback for the e-module that was created utilizing the PBL paradigm, which was focused on Batak Toba culture. Following the evaluation, the e-module under development underwent a revision process, and trial II examined the outcomes of the modifications or enhancements made to trial I's findings.

Table 9 provides an explanation of the growth in the students' capacity to solve mathematical problems based on each indicator in each trial.

Table 9. N-Gain Increases Mathematical Problem Solving Ability Based on Indicators

Indicator	First Trial	Second Trial
Understanding the problem	0,456	0,775
Planning the solution	0,425	0,582
Solve the problem	0,369	0,413

Description of the increase in student self-efficacy based on indicator in each trial is shown in Table 10.

Table 10. Increasing Students' Mathematical Self-Efficacy Based on the indicators

Indicator	First Trial	Second Trial
Level	0,261	0,276
Strength	0,198	0,259
Generality	0,208	0,248

The learning process employing the Toba Batak culture-based PBL approach, which starts with issues so that students can draw on prior knowledge to comprehend and solve mathematical problems, is what causes the development in students' self-efficacy abilities. The purpose of difficulties is to give the learning process greater significance, so that students may understand that they can be used as a springboard for building their self-efficacy skills. Additionally, student-led conversations serve as a link amongst students to aid in one another's knowledge of the issue. Ausubel's theory (Trianto, 2010) states that meaningful learning is the process of connecting newly learned material to ideas that are already present in an individual's cognitive structure. This is consistent with what this suggests. When learning something valuable, the process of building knowledge begins with a challenge. That is, when learning is integrated with problems or done through the use of the PBL learning model, students' information will start to make sense.

3.1.4 Implementation

The overall implementation of learning in the implementation test, as indicated by Figure 4 below, is 3.64. In reference to the implemented learning implementation criteria, the scores obtained from student observations of learning implementation meet the requirements for achieving the practicality of e-module.

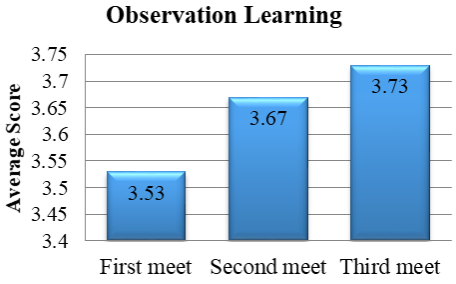

Figure 3. Observation Learning

The implementation of the PBL B3T e-module enhances the students' ability to solve mathematical problems. The class IX-2 implementation yielded an average N-gain of 0.506, falling into the "medium" range (0.30 < N-gain ≤ 0.70).

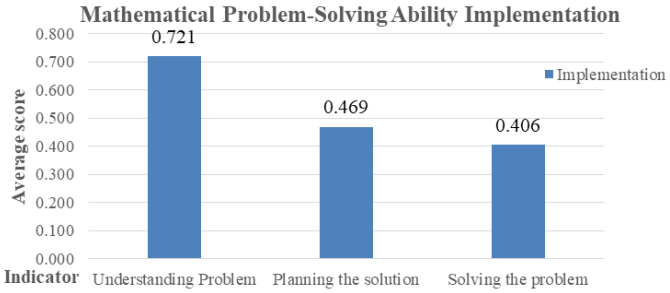

Figure 4. Problem-Solving Increasing

Table 11 provides an explanation of the rise in student self-efficacy based on the indicator.

Table 11. Self-Efficacy Increase

Indicator	Class IX-2
Level	0,469
Strength	0,242
Generality	0,308

Students' average score N-Gain self-efficacy during implementation was 0.338, falling into the "medium" range (0.30 < N-gain ≤ 0.70).

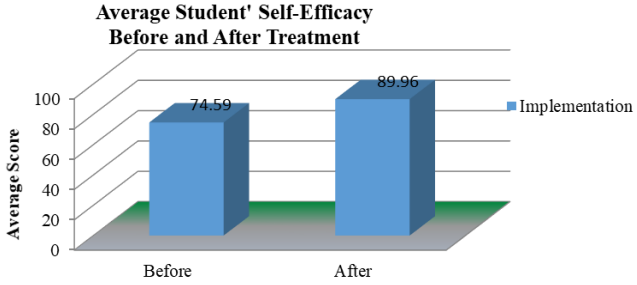

Figure 5. S-E Before After Treatment

The proportion of positive student replies is greater than or equal to 80% of students who provide positive responses to the e-module being produced, according to the effectiveness criteria and the ideal score percentage calculation in implementation positive replies (94.62% > 80%). It was obtained from the student response data in accordance with the learning aspect requirements, indicating that the learning process was engaging rather than tedious and that it made simpler for students to comprehend the subject.

3.2 Discussion

The fact that the issues in this research were grounded in the local cultural context helped students overcome their resistance to the challenges, which in turn enhanced their capacity for problem-solving. The architectural concept for Ambarita Harbor's roof, which is based on the roof of Ruma Bolon, is an illustration of a difficulty that also exists in this e-modul. Due to Ambarita Harbor's proximity to Simanindo 1 Middle School kids' homes and places of education, the problem was brought about due of how the students perceived the harbor's roof. Students are instructed to write down what they know and ask questions based on what they write down in the e-module. Following this, students are given instructions to plan a problem solution and create a solution based on the plan. The way mathematical problems are presented within the context of Toba Batak culture helps students become more adept at solving issues for each indicator. A problem solver can apply the techniques or procedures created by Mason (2010), which are consistent with Polya's theory, to solve an issue.

E-modul is supported with scaffolding and work examples. Every student is expected to report the results of the problem-solving exercises that have been discussed in class, and the instructor provides feedback regarding the assignments or presentations in question. In addition to that, alternative problem-solving

strategies for the topic are also provided in an e-module that can be used as a model for independent or self-directed learning.

The teacher provides motivation for learning in class by using the wise advice of the Batak tribe. Students working in groups are supposed to help one another, according to their traditional wisdom: "*tinaon barakbak, dapotsa papaluan; lehet masioloan, unang masipamaluan*" means "support each other, don't embarrass your friends." The Batak umpasa also advised "*bisuk songon ulok, marroha songon darapati*," which translates to "be as clever as a snake and wise as a dove." These ancestor messages are all helpful in producing intelligent, ethically pure children. A good example of umpasa, or Batak Toba cultural values, is "*manat unang tartuktuk, dadap unang tarrobung*" (slow down so as not to trip, be careful so as not to fall). These values urge students to work carefully when given an assignment to address a problem. These motivations make positive impact for students' learning math in class.

This study also matches up with (Sinaga, 2014). He introduced the *dalihan na tolu* (Batak Toba cultural system) into the teaching of mathematics.

D. CONCLUSION AND SUGGESTIONS

The e-module on ethnomathematics can be deemed valid (based on research instruments and e-module validation results), practical (based on learning implementation observation results), and effective (based on positive student responses and the ability to solve problems), primarily from the discussion above. The following suggestions can be made in light of the research's results and findings :

1. To ensure that the e-module assessment questionnaire is valid, it is advised that other researchers do a questionnaire validity process beforehand.
2. It is essential to have observers who are familiar with Toba Batak culture available for the application of learning.
3. Since trial 1 and 2 employed the same class, so it is advised that trials employing distinct classes be conducted in order to evaluate the practicality and effectiveness of the e-module.

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