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Practical Teaching Materials for Transformational Geometry Based on Visuals Ethnomathematics for SMA Toraja Class IX

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this research and development is twofold: firstly, to analyse the level of validity of teaching materials for transformation geometry based on visual ethnomathematics of Toraja carvings in Senior High School; and secondly, to analyse the level of practicality of teaching materials for transformation geometry based on visual ethnomathematics of Toraja carvings in Senior High School. The subjects in this development research consisted of three validators: linguists, material experts and media experts, as well as three mathematics teachers and 31 students at SMAN I Tana Toraja. Data collection was conducted through observation, interview sheets, teaching material validation sheets, teacher response questionnaires and student responses. Data analysis techniques were employed using both descriptive qualitative and descriptive quantitative approaches. The results of the qualitative descriptive data analysis yielded a

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number of suggestions for improvement from expert validation, teachers and students. The quantitative descriptive analysis revealed that the validation results from experts were of a very high standard, with a value of 85.56 in terms of language, 85.16 in terms of material, and 81.17 in terms of learning media. Moreover, the practicality of the developed teaching materials was rated as "very practical" by both teachers and students, with scores of 88.54 and 85.06, respectively.

Keywords: Teaching materials; transformational geometry; ethnomathematics; Toraja carvings.

1. INTRODUCTION

Mathematics is a subject that is always included in the curriculum at every level of education, starting from elementary, junior high, high school, and even up to university. The National Council of Teachers of Mathematics (NCTM) states that the main standards in learning mathematics in schools are problem-solving skills, communication skills, connection skills, reasoning skills, and representation skills [1].

In the process of learning mathematics, many forms of problems occur, one of which is as stated by [2] is the lack of mastery of appropriate learning methods and approaches to be used in each different class. Mathematics is increasingly less attractive to students so that sometimes what happens during math learning hours is that students are less actively involved in learning. Assessments of math that make students uninterested in learning as stated by Siswono, [3] that in learning mathematics sometimes the presence of educators in the classroom seems like an uninvited guest. Learners are not active or learn to do activities half-heartedly. Learners are reluctant to cooperate, group, carry out, and try hard to solve problems or tasks.

One way to bring math closer to students' real-world situations is to relate to what is around students, one of which is their culture. It is a fact that mathematics is inseparable from culture. The use of mathematics in culture is what is called ethnomathematics. Research by Abi [4] concluded that "The role of ethnomathematics is very important as a means to motivate, stimulate students, can overcome boredom and provide new nuances to mathematics learning. Because ethnomathematics is already known by students so that in inviting students to identify and associate parts of the culture they already know into a mathematical material ".

One form of ethno developed by researchers is to use Toraja culture as a teaching material to teach transformation geometry material. One of the Toraja cultures that can be used as learning media is carving. In the local language carving is also known as "passura'. Toraja carving (passura') contains the meaning of the struggle of life, how the descendants of a tongkonan should interpret their lives, such as hard work, mutual respect, the sweet-bitter life of unity and so on [5].

Seeing how noble the intentions of the carvings that have been inscribed by the ancestors of the Toraja people, one of the efforts to introduce Toraja carving culture to the next generation is that this culture is brought into learning activities. This is considered possible because existing research has found that Toraja carvings are rich in mathematical concepts. One of the research that states this is [6].

> *"Toraja's typical carving design also contains mathematical elements, especially in the basic concept of geometry transformation. Generally, the concept of reflection is seen in every design of Toraja's carvings such as Pa'tedong, Pa'barre Allo, Pa'manuk Londong, Pa'lamban Lalan, Pa'kangkung, Pa'barana 'I, and Pa'tanduk Re'pe. The concept of translation can be seen in Pa'sussu', Pa'dadu, Pa'lamban Lalan, Pa'ara' Dena I, and Pa'kangkung designs. Rotation concept can be seen on Pa'kapu 'Baka, Pa'salaqbi dibungai, Pa'kangkung, and Ne'Limbongan designs, while the concept of dilatation is seen on the designs of Pa'kangkung, Pa'barana 'I, and Ne'Limbongan."*

2. METHODS

Research and development that aims to develop a product, namely ethnomathematics-based transformation geometry teaching materials Toraja carvings. The design of this development research is described as follows:

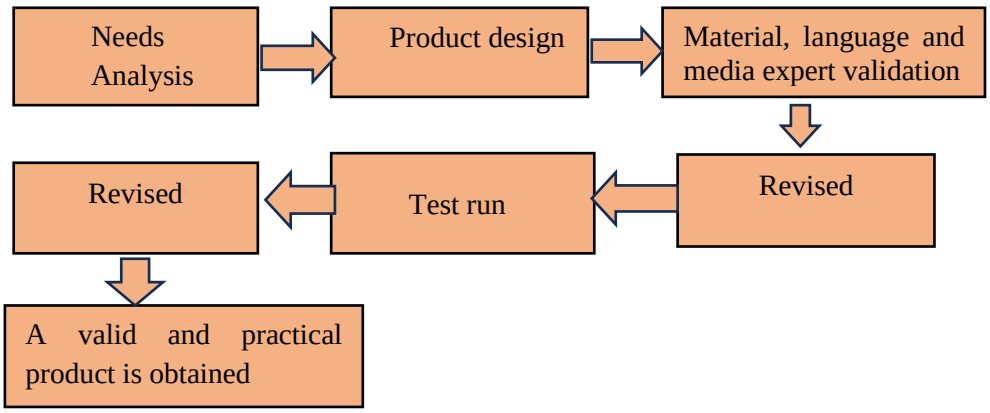

Fig. 1. Product research and development design

The needs analysis stage is useful for determining the needs in the learning process and collecting various information related to the product to be developed. (1) conduct a study on the definition and elements of a textbook (2) conduct a study on ethnomathematics, (3) conduct a study on Toraja carving. (4) see and identify the characteristics of students, curriculum, teacher conditions, real conditions of learning activities.

This product design stage aims to design a learning device that will be used in learning. This stage is an activity in choosing media, choosing formats, and designing initial products.

The validation stage is carried out by experts in order to examine and provide input on things that must be in the geometry of transformation teaching materials. The experts' assessment contains aspects of format, language, suitability of material or content, and image design. Based on the assessment and suggestions from the validators, improvements were made. Teaching materials are revised by including parts that need to get additions, subtractions, and corrections about various things in teaching materials to make them more precise, and have high quality.

Product trials were conducted to test the products that had been developed with the aim of obtaining input from teachers and students. Furthermore, the data obtained will be the basis for making improvements to the teaching materials. The trial in this study will be conducted for one class of XI grade high school students. To collect data, teachers and students as users of the teaching materials were given a questionnaire to fill in by selecting options that correspond to what they experience from using the teaching materials.

The instruments used in this research include interview guidelines, a validation questionnaire, a teacher response questionnaire, and a student response questionnaire. The validation questionnaire was provided to experts to gather assessments and feedback. Additionally, teachers and students received instruments in the form of questionnaires and interview guidelines to collect input during the small group trial of the developed product. The formula employed to analyze the results of expert validation is as follows:

$$K_{ij} = \frac{\sum_{H}^{n} = VH_i}{n}$$

By:

K_{ij} = average of i-th aspect
VH_i = the average of the hth validator's assessment for the i-th aspect
n = number of validators

Furthermore, the average validation of all aspects is:

$$RTV = \frac{\sum_{i=1}^{n} A_i}{n}$$

With:

RTV = Average total validity
A_i = Average of i-th aspect
n = number of aspects

The validity category is assessed based on the categorization criteria as developed by Sugiyono in [7] as follows:

Table 1. Product development validity categories

No.	Interval	Category
1	82-100	Very Valid
2	63-81	Valid
3	44-62	Invalid
4	25-43	Very invalid

The formula used to analyze the results of teacher and student responses to the practicality of using teaching materials is as follows:

$$RSP = \frac{n}{N} x100$$

Description:

RSP = Average assessment score
n = Number of scores obtained
N = Maximum number of scores

Furthermore, the level of teacher and student responses is based as in Table 2 below

Table 2. Categories of teacher and student response questionnaire assessment scores

Average score interval	Category
81-100	Very practical
61-80	Practical
41-60	Practical enough
21-40	Less Practical
0-20	Not Practical

Riduwan in (Afrizon & Dewi, 2019)

The conclusion based on this data is that the majority of the teacher and student responses indicate that the practical teaching materials for transformational geometry based on visual ethnomathematics are either practical or practical enough. However, there is still a significant portion of responses that fall into the less practical and not practical categories, suggesting that there is room for improvement in the practicality of these materials.

3. RESULTS

3.1 Needs Analysis Phase

This first stage, data collection is carried out in the form of interviews and field observations, then conclusions are obtained related to the need for teaching materials that:

1. It takes a variety of learning resources that can be used by students to learn each material.
2. The book used to teach transformation geometry material is still limited to books developed in general and the book is not fully sufficient to be shared with students to be studied independently.
3. Students understand more easily if they use things related to their surroundings.
4. Teachers do not have textbooks related to culture or things that exist in the real world of students.

3.2 Product Design

The prototype of this teaching material development, in general, consists of a cover, introduction, core and evaluation. The introduction consists of identity, description, subject matter and instructions for using teaching materials. Furthermore, the core section consists of a brief description, description of learning outcomes, material descriptions, summaries, practice questions and the last is an evaluation consisting of a collection of questions related to the overall geometry of transformation. The cover part is as shown in Fig. 2.

3.3 Product Validity Test

The teaching materials developed must meet the valid or very valid category of the predetermined experts, namely material experts, media experts and linguists. Aspects that are the subject of assessment from validators such as, the suitability of the material with SK, KD; or learning objectives, suitability to the format, suitability of selecting the right media, writing in accordance with grammar and others.

The following is a description of the data from the analysis of the validity of teaching materials in terms of material as shown in the table below:

Based on Table 3, the results of the material expert validation show that the expert assessment in terms of learning material is declared "very valid" with an average score of 85.16.

Furthermore, the data exposure of the results of the analysis of the validity of teaching materials in terms of media as shown in the table.

Based on Table 4 above, the results of media expert validation show that the expert assessment in terms of learning media is declared "valid" with an average score of 81.17.

Table 3. Results of product validation from the material expert side

Elements	Validator	Description
Components of teaching materials	85	Very Valid
Material	82,5	Very Valid
Verbal	90	Very Valid
Exercise	85	Very Valid
Image	83,33	Very Valid
Average 85.16		Very Valid

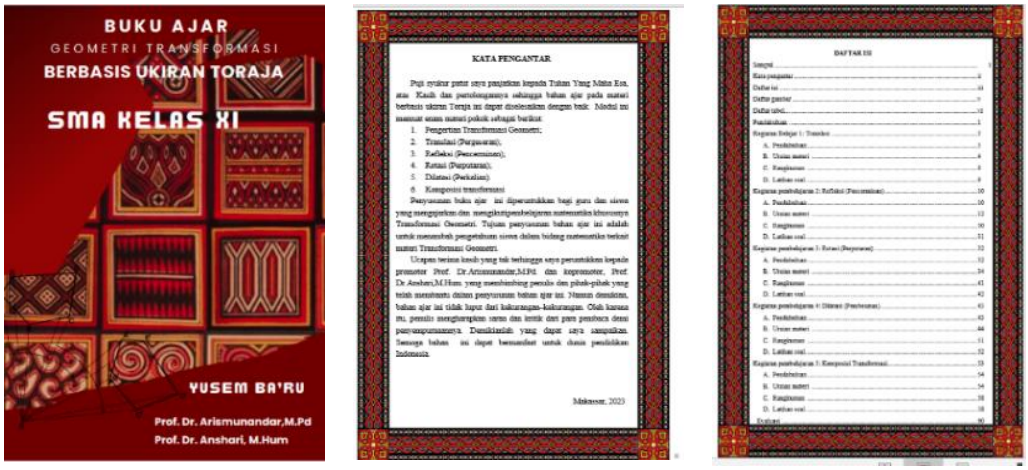

Fig. 2. Cover, foreword, and table of contents design

Table 4. Product Validation Results from Media Sector

Aspects	Validator	Description
Size	80	Valid
Cover	80	Valid
Layout/graphics	78	Valid
Lettering Usage	86,67	Very valid
Average	81,17	Valid

Furthermore, in terms of linguists, validity data is obtained, as follows:

Based on Table 5, the results of linguist validation show that the development of teaching materials is declared "very valid" with an average score of 90.42.

3.4 Product Revision Based on Validator Feedback

There are several suggestions from linguists, materials and media for improving the developed teaching materials, in summary as follows:

1. The writing on the cover is not clear enough. The validator suggested using a combination of letter and *background* colors so that it is clearly visible and easy to read. This suggestion has been improved by changing the font color to black so that the writing on the cover becomes clear to read.
2. Sources of material should not be just a few but many.
3. This suggestion has been improved by taking some relevant source material to be included in the developed teaching materials.
4. The materials developed are monotonous.
5. The validator suggested changing the design of the worksheets at the end of each material to worksheets on each topic in the teaching materials. This is done so that students are involved in the project so that they are not passive in following the learning that is temporarily taking place.
6. There are still learning objectives that are not formulated operationally.

7. This suggestion has been improved by changing the word "understand" to a more operational "explain".
8. Layout or clarity of images in explaining the material is more clarified.
9. The validator suggested choosing the color integration of the writing on each carving image to be adjusted so that the dots and writing are easily readable.

3.5 Practicality Trial of the use of Teaching Materials

The practicality test is intended to assess the extent to which the teaching materials can be used effectively by teachers and students. Testing the practicality of teaching materials is measured by giving a questionnaire teacher response and student response after they use teaching materials in learning geometry transformation.

Data collection on teachers' responses was conducted after teachers used the teaching materials. In this study, there were three mathematics teachers at UPT SMAN I Tana Toraja as research subjects. The following is the data of teacher response research results:

Based on the data exposure in Table 6, it can be seen that the teacher gave a very good response. The average score obtained is 88.54 with a very practical category.

Furthermore, research data on student responses were collected using 31 research subjects. This data was collected after students learned to use transformation geometry textbooks.

Based on Table 7, we can see that the student response score is 85.06 with a very practical category.

3.6 Product Revision based on Suggestions from Teachers and Students

In general, teachers and students have responded very positively, with only a few suggestions, namely that there are some typos in the text and these suggestions have been corrected.

Table 5. Results of product validation in terms of linguists

Aspects	Validator	Description
Appropriateness of language to the developmental level of learners	86,67	Very Valid
Communicativeness	100	Very Valid
Orderly flow of thought	90	Very valid
Use of good and correct language	85	Very valid
Average	90,42	Very Valid

Table 6. Results of teacher response to the product

No.	Aspects	Subject (subject teacher)			$\bar{x}$	Criteria
		S1	S2	S3		
1	Introduction.	91,67	83,33	91,67	88,89	Very practical
2	Ease of understanding Language and materials	86,11	83,33	88,89	86,11	Very practical
3	Availability of summaries	87,5	87,5	87,5	87,5	Very Practical
4	Evaluation availability	91,67	91,67	88,31	91,67	Very Practical
Average score					88,54	Very practical

Table 7. Results of Student Response to the Product

No		Average score	Criteria
1	Ease	81,65	Very practical
2	Sustainability	87,36	Very Practical
3	Design	88,70	Very Practical
4	Interest	82,52	Very Practical
Average 85.063			Very Practical

4. DISCUSSION

Based on the results of research and development that have been described, it is concluded that the results of validation analysis from three experts are very valid. Furthermore, the analysis of teacher and student responses concluded that the teaching materials developed had met the practical requirements.

Based on the needs analysis of this teaching material development, it illustrates that one of the important steps to design an effective learning environment is to find what students need so that they will be able to maximize their full potential to learn. Analyzing student needs is very important for designing and developing curriculum, such as helping teachers to choose learning media, appropriate learning models, and or helping teachers to design learning. This is as said by Hamzah B. Uno et al. [8] that understanding students well, it is hoped that we can provide appropriate and useful educational services for each child. Therefore, understanding the various needs of children in learning is important, so that we can detect what services, and how should be provided to meet their learning needs.

One of the learning resource designs around students is to incorporate local wisdom values into mathematics learning. Ferdianto & Setiyani, [9] stated that one of the efforts that can be made to incorporate local wisdom values is by designing, creating and developing teaching materials based on local wisdom values. Furthermore, this is similar to the opinion of Andriono, [10,11] which states that there are several impacts of implementing ethnomathematics-based learning, including: (1) making mathematics learning fun and contextual; (2) getting to know one's own culture and other cultures; (3) fostering awareness of appreciating and loving one's own culture and other cultures; (4) making students realize that mathematics is fun and exists in every activity of human life; and (5) being part of cultural preservation efforts through mathematics education.

The teaching materials developed in this study are designed in the form of Toraja carvings to make it easier for students to see the geometric forms of transformation directly. Students will see changes in each point with the treatment of geometric transformations on Toraja carvings that fulfill each of these concepts. With the help of Toraja carving media that can be observed by students, students will be guided by worksheets (LK) that will be filled in by students to help them find their own concepts contained therein. This form of learning was initiated by adherents of constructivism learning theory. Constructivism learning theory emphasizes that knowledge discovered by students themselves through will be meaningful learning. This is as said by Islamiati, [12] It is expected that with students actively involved in seeking or exploring knowledge, a meaningful learning will be created for students so that it will provide a strong understanding and improve student learning outcomes.

At the validity test stage, valid is the minimum requirement that must be met to ensure the feasibility of using the resulting product. Completeness of teaching material components, language (verbal), presentation of material, exercises, and graphics are components assessed by the validator. The purpose of this validation is to evaluate and improve the results of the development of teaching materials carried out by the author. The above is in line with Sekaran's opinion in [13] that content validity ensures that measurements include an adequate and representative set of items that reveal the concepts to be conveyed.

Furthermore, the thing that must be seen from the development of this teaching material is the practicality seen from the teacher's response and the student's response as the user of this product. Through discussions with several mathematics teachers obtained information that teaching materials based transformation geometry Toraja carving developed is very suitable for use in the learning process in the classroom. It is considered that Toraja Carving is a culture that is passed down from generation to generation so that it will be very easy to understand by students if used in the teaching and learning process who are familiar with it. Ramdhan et al. [14] stated that the difficulty for students to understand the mathematics obtained at school and the difficulty for students to connect it with real life make the main factor in the importance of integrating culture-based learning in learning.

Based on the above problems, the presence of teaching materials packaged in the form of culture will allow teachers to teach transformation geometry very easily. As said again by Abi, [4] that because ethnomathematics is already known by students, it will be easier for teachers to direct them to identify and relate parts of their

culture to mathematical materials with the guidance provided by the teacher. This is the reason why the role of ethnomathematics is very important as a means to motivate, stimulate and provide new nuances in mathematics learning. This is in line with the opinion of Sudirman [15] that "Ethnomathematics represents real cultural objects in mathematical concepts" which means that ttnomathematics represents real cultural objects in mathematical concepts.

In addition to the above, the teacher also stated that this form of teaching material is very suitable to be applied in the formation of student character, this will help teachers to convey character-based values because in addition to students being taught geometry transformation material students will also be equipped with philosophical values of life that become the provision of their personality to be resilient and integrity. This is in accordance with the results of research [16] which states that the internalization of the value of toraja carving in formal education that each carving has a meaning that contains character values. Teachers can use carvings as a medium in telling stories, for example the origin of the name of the carving and its meaning. This is also in line with what was said by Jainuddin et al. [17] that the meaning contained in these carvings is in the form of good advice in the form of messages so that people always live life well, always work hard, respect each other, and always foster unity and kinship and piety to God Almighty. Furthermore, it is said that with this teaching material, teachers can link the material studied with local wisdom in the learning process. It is intended that students can know the local wisdom that exists in their area, then preserve the values contained therein. Syahrial et al. [18] further said Daniah, [19] that the strategy to change the values that are considered important for children to have is to understand local wisdom that has been passed down through generations through fairy tales, legends, and traditional advice. Based on the situation they face, learning materials must have significant meaning and relevance to their life empowerment.

Furthermore, the ease with which students can understand the material provided by a learning resource will make them not feel bored and what is presented in it will be easy to understand. These things must be of full attention in the presentation of mathematical material which is indeed an abstract object of study. One way to bridge students to easily understand the abstract object of study of mathematics is the use of their culture in learning. The relationship of mathematics that students learn at school if it is associated with their real life will make students challenged to learn and motivated in learning. This was obtained during the research that the students' response to follow the lesson well was greatly influenced by the understanding that there were mathematical concepts related to their lives. Some said that "it turns out that math can be observed directly in toraja carvings", some said that "toraja carvings help find transformation geometry formulas". In addition there are those who say that "not bored in learning math by using textbooks that use Toraja carvings and make me able to understand the meaning of the carvings".

Fajriyah, 2018a [20] states that culture-based mathematics learning will be an interesting, fun, and innovative learning alternative because it allows contextual meaning based on students' experiences as members of a cultural community so that it is expected to participate in supporting the literacy movement.

Furthermore, research results [11] that the impact of the application of ethnomathematics learning is several such as: (1) Mathematics learning becomes fun and contextual learning; (2) Can reduce the impression that math is difficult and abstract and replaced with the impression that math is fun and real in every life activity.

5. CONCLUSIONS

The development of teaching materials based on Toraja carvings produces products in the form of textbooks. This image-based teaching book can be seen from the form of writing, colors and images that are packaged in the form of Toraja carvings. Transformation geometry textbooks are declared very valid based on the results of the validation of a team of material and language experts and valid from media experts with validation scores of 85.16, 90.42, and 81.17 respectively. Transformation geometry textbooks are declared to be very practical to use based on the results of observations, teacher and student response questionnaires with scores of 88.54 and 85.06 respectively.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Maulyda M. NCTM Based Mathematics Learning Paradigm; 2020.
2. Sari RK. Analysis of Mathematics learning problems in junior high schools and alternative solutions. Prismatics: Journal of Mathematics Education and Research. 2019;2(1):23–32.
3. Siswono TYE. (n.d.). Mathematics learning problems and efforts to overcome them. Available:https://www.academia.edu/57523 92/Perprobleman_Pembelajaran_Mathema tics_dan_Efforts_To Overcome It Retrieved August 10, 2022,
4. Abi AM. Integration of Ethnomathematics in the School Mathematics Curriculum. JPMI (Indonesian Journal of Mathematics Education). 2017;1(1).
5. Situru RS, Sumule PG, Ake SR. Efforts to prevent corruption in society through anti-corruption education based on the Toraja Carving Philosophy. Proceedings of the Indonesian Christian University of Toraja, 1(1), Article 1; 2021.
6. Nugraha YS. Ethnomathematical review of Toraja's typical carving design in geometry transformation learning. Journal of Physics: Conference Series. 2019;1280(4): 042020.
7. Riza FY, Antosa Z, Witri G. Development of multicultural based student worksheets in arts, culture and crafts learning for class V Elementary Schools. Journal of Elementary School Education and Learning Innovation. 2020;4(2):21–32.
8. Devianti R, Sari SL. The Urgency of Student Needs Analysis of the Learning Process. Al-Aulia: Journal of Islamic Education and Sciences. 2020;6(1):21–36.
9. Ferdianto F, Setiyani S. Development of learning media teaching materials based on local wisdom for mathematics education students. JNPM (National Journal of Mathematics Education). 2018;2(1):37–47.
10. Andriono R. Analysis of the Role of Ethnomathematics in Mathematics Learning. ANARGYA: Scientific Journal of Mathematics Education. 2021a;4(2).
11. Andriono R. Analysis of the role of ethnomathematics in mathematics learning. ANARGYA: Scientific Journal of Mathematics Education. 2021b;4(2).
12. Islamiati SA. (n.d.). Implementation of constructivist learning theory through integrative thematic learning to create meaningful learning.
13. Hendryadi H. Content Validity: Initial Stages of Questionnaire Development. Journal of Management and Business Research. 2017;2(2):259334.
14. Ramdhan M, Kadir Prajono R. Analysis of Teachers' and Students' Understanding of Kain Tolaki's Ethnomathematics. Journal of Educational Charities. 2022;3(3):Article 3.
15. Mutaqin A, Syaifuddin M, Cholily YM. Ethnomathematics Based Geometry Module Development with a Scientific Approach to Improve Students' Metacognition Ability. IndoMath: Indonesian Mathematics Education. 2021; 4(1):11–25
16. Tulak H. Internalization of Toraja Carving Culture in Education. Journal of Teacher Training and Education. 2019;8(3):37–40.
17. Jainuddin J, Silalong ES, Syamsuddin A. Ethnomathematical exploration of Toraja Carvings. Delta-Pi: Journal of Mathematics and Mathematics Education. 2020;9(2).
18. Syahrial Asrial, Kurniawan DA, Piyana SO. E-Module Ethnoconstructivism: Implementation in Class V of Elementary Schools in View of Perception, Interest and Motivation. JTP - Journal of Educational Technology. 2019;21(2).Article 2.
19. Daniah D. Local Wisdom as a Basis for Character Education. PIONEER: Journal of Education. 2016;5(2).
20. Fajriyah E. The role of ethnomathematics related to mathematical concepts in supporting literacy. PRISMA, Proceedings of the National Seminar on Mathematics. 2018a;1:114–119.

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