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IMPLEMENTATION OF ETHNOMATHEMATICS-BASED LEARNING OF MANDALIKAN BANTEN BATIK MOTIFS IN IMPROVING STUDENTS' ABILITY TO UNDERSTAND MATHEMATICAL CONCEPTS AND PRODUCTIVE DISPOSITION

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ABSTRACT

This study aims to determine the effectiveness of the implementation of ethnomathematics-based learning in the context of the Batik Mandalikan Banten motif in improving students' ability to understand mathematical concepts and productive disposition, as well as identifying mathematical elements in Banten culture. The method used is quantitative with a quasi-experimental design in the form of a pretest-posttest control group design. The research subjects consisted of two X classes at SMKS PGRI 3 Serang City, namely X DKV 1 as an experimental class and X DKV 2 as a control class. The instruments used were tests of ability to understand mathematical concepts and productive disposition questionnaires. Data analysis includes N-Gain calculation, normality, homogeneity, two-sample similarity test, and questionnaire percentage analysis. The results of the study showed that ethnomathematics-based learning of the Batik Mandalikan Banten motif was effective in improving students' understanding of mathematical concepts and productive disposition compared to conventional learning. In addition, mathematical elements in the form of rows and arithmetic sequences were found in the motif of Batik Mandalikan Banten, which was used as the context of learning materials. The integration of local culture in mathematics learning has proven to be a meaningful and innovative strategy, as well as encouraging student character in facing the challenges of learning mathematics

Keywords: Ethnomathematics-based learning, Batik Motif Controls Banten, Mathematical Comprehension Ability, Productive Disposition.

INTRODUCTION

Education plays a crucial role in human life because it functions to shape and produce superior and quality human resources. In the field of education, one of the mandatory learning is mathematics learning. Mathematics is the study of the logical study of forms, arrangements, quantities, and concepts related to each other. Therefore, mathematics is a subject that must be understood by students. However, mathematics is still considered a difficult, scary, and boring subject by some students because mathematics lessons are considered to be nothing more than arithmetic, playing with formulas and numbers that make students dizzy. (J. W. Pratiwi & Pujiastuti, 2020)

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Based on this, there is a need for a more innovative approach to mathematics learning that links mathematical concepts to the context of culture and daily life so that students are interested in exploring mathematics further. According to (Fajria Septiani, 2024), a learning approach that links mathematical concepts with the cultural context and daily life of students can be an effective solution. Therefore, it is important for mathematics learning to include elements of local culture as a bridge between the concept of school mathematics and mathematics found in students' daily environment. One approach that can be used is ethnomathematics.

Brazilian mathematician, (D'Ambrosio, 2001, 2001, 2007, 2018)) posits that ethnomathematics is mathematics practised among identified cultural groups such as tribal national societies, labour groups, children of certain age groups and the professional class. According to (J. W. Pratiwi & Pujiastuti, 2020)(J. W. Pratiwi & Pujiastuti, 2020)(J. W. Pratiwi & Pujiastuti, 2020)(J. W. Pratiwi & Pujiastuti, 2020) (K. R. Pratiwi, Nurmaina, & Aridho, 2022) , mathematics learning that integrates local culture or ethnomathematics is an effective and efficient approach in increasing students' interest in mathematics. Through ethnomathematics, material that was previously considered complicated and boring can be delivered in a way that is more contextual and easy to understand because it relates directly to the culture or daily life of students.

Several studies have produced findings about mathematical concepts that exist in culture, such as in traditional games, temples, batik motifs, traditional houses, and so on. Thus, one of the cultures that can be integrated in ethnomathematics learning is batik. According to Nugroho, batik is a pictorial fabric that is part of Indonesia's cultural heritage, combining elements of art and technology in the manufacturing process, which is carried out distinctively and distinctly (Safitri, Latifah, & Angelani, 2022). Batik is an Indonesian cultural heritage that has been recognised by the world since it was established by UNESCO on October 2, 2009 (Amalia, Syamsuri, & Ihsanudin, 2021). Indonesia has a variety of different batik motifs in each region. One of the regions that participates in creating batik typical of its region is Banten. One of the Batik from Banten is the Mandalikan Batik motif.

The Mandalikan motif was found at the archaeological excavation site where the prince of Mandalika lived during the Banten Sultanate. Prince Mandalika was the son of Sultan Hasanudin, from a mother who was not a permaysuri. The Mandalikan Batik motif comes from the basic motif of a rhombus in the shape of a flower in the middle of a star. The variation of the motif, the star in a chain box and the basic booh motif is in the shape of a triangular serrated triangle. The colour variation uses 3 colours of the basic motif in beige, the variation of the motif on a grey star, and the brown chain. The basic motif on this batik shows the naturalist character in the form of a flower and its petals. The Mandalikan Batik motif has the meaning of a memory of the prince of Mandalika, who once had a dispute with the Palace over his own beliefs. Mandalika's motive shows a struggle for self-confidence. With white-gray and dark blue colours in the basic motif, it shows the firmness of the truth that the prince of Mandalika wants to uphold. The variation of motifs shows the image of the Banten Sultanate Palace building, which is stepped and symmetrical.

The ability to understand mathematical concepts is a competency that shows the extent to which students understand and master the concepts of the material being studied. This ability is fundamental for students to have in the mathematics learning process, because it is the basis for thinking, solving problems, and developing further knowledge. (Sumarsono et al., 2022). Conceptual understanding is an important foundation in building new knowledge and supporting students' ability to solve complex problems. Students who understand concepts can relate concepts and procedures, as well as explain reasons logically. This ability is an essential basic competency because it allows students to apply mathematical concepts in solving problems and daily life situations. Therefore, understanding concepts plays a crucial role in learning mathematics.

In addition, another thing that affects students' ability to solve problems is productive disposition. BSNP in Pradella & Bahri's (2022) research states that in addition to cognitive abilities, students also need to have and develop affective abilities in mathematics learning. These affective abilities include an attitude of appreciating the usefulness of mathematics in daily life, curiosity, attention, and interest in learning mathematics. Based on this expression, productive disposition is one of the goals of mathematics learning in schools that is important to achieve.

The results of observations on grade X students at SMKS PGRI 3 Serang City show that the understanding of mathematical concepts and productive disposition is still relatively low. One of the reasons is the use of conventional learning models that only emphasise memorisation and imitation of examples, so that learning feels less meaningful and uninteresting. This approach does not encourage students to actively build understanding, and there is little connection to the local culture, making mathematics seem irrelevant to daily life. The interview results also show that many students find math difficult, complicated, and boring because learning only focuses on theories and formulas without any real context, thus lowering students' interest in learning.

This can be seen from the initial observation of students' ability to understand mathematical concepts that have been carried out by the researcher, from the students' answers found that some students answered questions that were not appropriate. The following are observation questions for students of arithmetic row and series material:

1. It is known that an arithmetic row is 3,7,11,15...

   Determine the difference and the 6th quarter of the Arithmetic line!
2. Determine the first six syllables of the row that have the nth syllable formula, which is Un 3n-n!

Below are students' answers to arithmetic row and series material problems.

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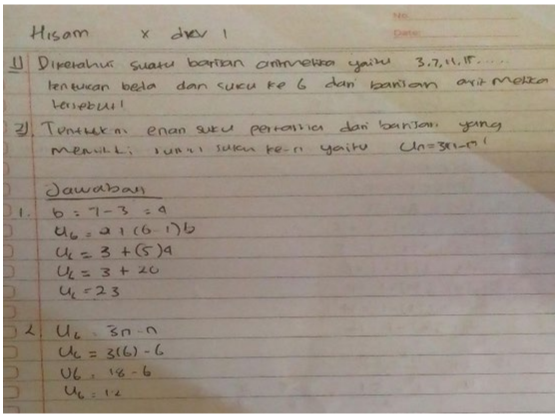

Figure 1. Students' Concept Understanding Ability

From the student's answer, it can be seen that in question number 1, students answered the question correctly, but it was not complete and not in accordance with the indicator of concept understanding ability, namely, Interpreting. In question number 2, students answered the question with incorrectly answers, because they were not thorough and did not understand when reading the questions. It can be seen from the answers of students who were looking for the 6th tribe, as if students were looking for the first six tribes of the formula of a line. Therefore, students are not by the exemplifying and classifying indicators, so they are not able to master the indicators of concept understanding ability in problem solving.

It can be concluded from these questions, the ability to understand concepts plays a big role in determining the results of student learning in mathematics. Students who have good concept understanding skills will find it easier to learn and solve mathematical problems. Therefore, in the mathematics learning process, it should be focused on efforts to improve the ability to understand concepts, so that students have a strong foundation in understanding mathematics material and have confidence and motivation to learn in mathematics lessons. Based on the background description above, the problem that can be overcome is the implementation of the application of ethnomathematics-based learning in improving students' ability to understand mathematical concepts and productive dispositions. This can be done by relating and providing examples of mathematical concepts in the Banten Mandalikan Batik motif, which is one of the Banten cultures.

METHODS

This type of research is quantitative research, which emphasises collecting and analysing data in the form of numbers to conclude. The method used is a *quasi-experimental design,* with a pretest-posttest control group design. This design involves two randomly selected groups (random sampling), namely the experimental class and the control class. In this study, the researcher wanted to find out whether the ability to understand concepts can increase after being given ethnomathematics-based

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learning compared to conventional learning, as well as students' productive disposition to experience an increase in ethnomathematics-based learning.

This research was carried out at SMKS PGRI 3 Serang City, which began in May 2024 until it was completed with class X DKV 1 as an experimental class and X DKV 2 as a control class. This research instrument consists of: (a) Teaching Module instruments and student worksheets. (b) an interview test instrument for the Banten Batik Mukarnas in the Ciposok Jaya area, Serang City, a written test of 5 description questions to strengthen the ability to understand mathematical concepts, and *students' productive disposition*.

The data analysis techniques used in this study are analysis of the ability to understand mathematical concepts in the form of (descriptive analysis, N-Gain Test, N-Gain Normality Test using *Kolmogorov-Smirnov*, N-Gain Homogeneity Test using *Levene statistic*, and N-Gain Average Two Similarity Test), and Analysis of *student* productive disposition

FINDINGS

This study was conducted to test whether there is an increase in students' ability to understand mathematical concepts and *productive disposition* through ethnomathematics-based learning of Batik Mandalikan Banten motifs.

Analysis of students' ability to understand mathematical concepts.

Descriptive Analysis.

After the implementation of the research, data were obtained on the results of the pretest and posttest tests on students' ability to understand mathematical concepts on arithmetic row and series material, using a description test instrument. The research was conducted in class X DKV 1 (experimental class) and X DKV 2 (control class), each totalling 34 students. The Normalised Gain (N-Gain) analysis used SPSS version 26 to see the impact of ethnomathematics-based learning of the Batik Mandalikan Banten motif on improving understanding of mathematical concepts, with an ideal maximum value of 100. The average results of the N-Gain score are presented as follows:

Table 1. Results of N-Gain Descriptive Analysis

	Eksperimen			**Control**		
	Pretest	**Posttest**	***N-Gain***	**Pretest**	**Posttest**	***N-Gain***
Minimum	25	80	57	5	15	8
Maksimum	65	100	100	75	80	43
Mean	43,97	90,15	82,93	35,00	51,76	26,86
Std, Deviation	11,131	5,434	-	17,145	16,185	-

Based on the table, the average ability to comprehend mathematical concepts of students in the experimental class before treatment was 43.97 (highest score 65, lowest 25), and increased significantly

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after ethnomathematics-based learning to 90.15 (highest 100, lowest 80). In the control class, the initial average was 35.00 (highest 75, lowest 5), and after conventional learning only rose to 51.76 (highest 80, lowest 15). These findings show that ethnomathematics-based learning of the Batik Mandalikan Banten motif provides a significant improvement in the understanding of mathematical concepts compared to conventional learning. This is supported by the N-Gain score, where the experimental class averaged 82.93% (effective category), with a range of 57%–100%. Meanwhile, the control class only obtained an average of 26.86% (ineffective category), with a range of 8%–43%. Thus, the implementation of ethnomathematics-based learning of the Batik Mandalikan Banten motif has been proven to be effective in improving students' understanding of mathematical concepts compared to conventional methods.

N-Gain Normality and Homogeneity Test

The normality test in this study showed that the Sig. The Value for the test of students' mathematical concept comprehension ability in the experimental class was 0.187 and 0.200 in the control class. Thus, it can be concluded that the experimental class and control class data are normally distributed.Meanwhile, the homogeneity test showed a value of Sig. 0.704, which means Sig. > 0.05, which can be interpreted that the variance of the data is homogeneous.

N-Gain Two-Average Similarity Test

Based on the output table of the independent sample t test, a Sig. (2-tailed) A value of 0.000 was obtained, which means $P < 0.05$. Thus, it can be concluded that H_0 It is rejected and accepted, so that there is a difference in the experimental class or the control class before and after being treated. This means that students' mathematical reasoning skills improve after being given treatment.H_1.Thus, ethnomathematics-based learning of the Batik Mandalikan Banten motif has been proven to have a significant influence on improving students' understanding of mathematical concepts compared to conventional learning. The average final score also showed that students who participated in ethnomathematics learning achieved a higher understanding of concepts than students with conventional learning.

Analysis of Students' Productive Disposition

A percentage analysis of each indicator of student productive disposition was carried out to determine the extent of achievement of each indicator. Data was obtained from 34 respondents in the experimental class and processed using the Microsoft Excel 2019 application to facilitate the process of calculating and presenting results systematically.

Table 2. Results of Students' Pretest Productive Disposition Before Treatment

No.	Indicator	Total Score	Percentage (%)	Criterion
1	Math as a sensible endeavour	441	64,85%	Good

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No.	Indicator	Total Score	Percentage (%)	Criterion
2	Mathematics is beautiful, useful and valuable	169	62,13%	Good
3	The belief that one can learn mathematics with the right effort	250	61,13%	Good
4	Mathematical thinking habits	406	74,63%	Good
5	Mathematical thinking habits	305	74,75%	Good
6	Positive goals and motivation	197	72,42%	Good
7	Self-Eficacy	244	59,70%	Good
	Average		67,12%	Baik

Table 1. Posttest Results of Students' Productive Disposition After Treatment

No.	Indicator	Total Score	Percentage (%)	Criterion
1	Mathematics as a reasonable endeavour	551	81,02%	Excellent
2	Mathematics is beautiful, useful and valuable	220	80,88%	Excellent
3	The belief that one can learn mathematics with the right effort	324	79,41%	Excellent
4	Mathematical thinking habits	473	86,94%	Excellent
5	Mathematical integrity and academic risk-taking	367	89,95%	Excellent
6	Positive goals and motivation	229	84,19%	Excellent
7	Self-Eficacy	315	77,20%	Excellent
	Average		82,79%	Excellent

Based on these data, it shows an increase in students' productive disposition after the implementation of ethnomathematics-based learning of Mandalikan banten batik motifs. This is shown by the increase in the average percentage of pretest results from 67.12% to 82,795 in the posttest. The increase reflects positive developments in the indicator of student *productive disposition*. Thus, the implementation of ethnomathematics-based learning of the Mandalikan banten batik motif can increase the productive disposition of students in the experimental class.

Ethnomathematical research on the mathematical elements contained in the Mandalikan Banten batik motif in the material of rows and series of Arithmetic that can be used as learning material, namely:

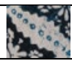
1. Arithmetic Lines

The Batik motif of Mandalikan Banten forms an arithmetic row pattern. When viewed from the direction of the motif, it will form an arithmetic row pattern, namely:

Figure 1. The Results of Ethnomathematical Discoveries

From the picture of the batik motif above, we observe that there are motifs with different directions in it, including.

Table 42. Results of the Identification of Batik Motifs Controlling Banten

No	Motive Description	Motif Images
1	Motif 1 (Oblique to the Right)	
2	Motif 2 (midway between oblique to the right and oblique to the left)	
3	Motif 3 (Oblique to the left)	

The motifs formed have a pattern that can be determined in order. For more details, consider the following image:

1 2 3 4 5 6 7 8 9 10 11 12

Figure *2*. Results of Arithmetic Rows

From the picture above, we observe that the Banten Mandalikan Batik motif with motif 1 (oblique to the right) has a pattern of 1,4,7,10. This means that each tribe of the pattern has a difference of 3 from the next tribe. Therefore, we can find out the next term 10 plus 3, which is 13. If adjusted to the pattern of arithmetic rows with a difference of 3, then for the n term, the formula is obtained: Un = 3n – 2

Next, we observe that motif 2 (the middle between the right oblique and the left oblique pattern) has a pattern of 2,5,8,11. This means that each tribe of the pattern has a difference of 3 from the next tribe. Therefore, we can find out the next quarter, 11 plus 3, which is 14. If adjusted to the pattern of arithmetic rows with a difference of 3, then for the n quarter, the formula is obtained: Un = 3n – 1

Next, we observe that the motif (oblique to the left) has a pattern of 3,6,9,12. This means that each tribe of the pattern has a difference of 3 from the next tribe. Therefore, we can find out the next quarter 12 plus 3, which is 15. If adjusted to the pattern of arithmetic rows with a difference of 3, then for the n quarter, the formula is obtained: Un = 3n

2. Deret Arithmetic

The motif of Batik Mandalikan Banten forms an arithmetic series pattern, when viewed from the number or number of rhombus fragments formed, which will form an arithmetic series pattern. The following will be presented as an example of a picture of the motif of Batik Mandalikan Banten.

1 2 3 4 5

Figure *3.* Arithmetic Series Results

From the picture above, we observe that the rhombus motif forms a row that has a pattern of 1,2,3,4,5. This means that each tribe of the pattern has a difference of 1 from the next tribe. Therefore, we can find out the number of rhombuses in the next tribe, which is 6. In addition, we can also find out the total number of rhombuses in the row if adjusted to the arithmetic sequence with a difference of 1 mka obtained for the number of n quarters obtained by the formula: $S_n = \frac{n}{2}\ (1 + n)$.

DISCUSSION

Reminding Students' Ability to Understand Mathematical Concepts Through Batik Motifs Controlling Banten

Based on the results of data processing, there was a difference in the ability to understand mathematical concepts between students in the experimental class and the control class. The average posttest of experimental class students who participated in ethnomathematics-based learning of the Batik Mandalikan Banten motif was higher than the control class that used conventional learning. This is in line with previous research that students' ability to understand mathematical concepts using ethnomathematics-based learning models has changed for the better, because students can solve existing problems according to their understanding. (Jaka Wijaya Kusuma, 2023).

This shows that ethnomathematics-based learning has the potential to improve students' understanding of mathematical concepts. Through this approach, students are invited to identify, explore, prove, and deduce mathematical patterns from cultural contexts, so that learning becomes more meaningful. This can be seen from the posttest results in the experimental class better than the posttest results in the control class, with the largest score of 4 points from the students' test results. The following are the results of the answer of one of the students after being given ethnomathematics learning (posttest) in the experimental class:

Question Item 1

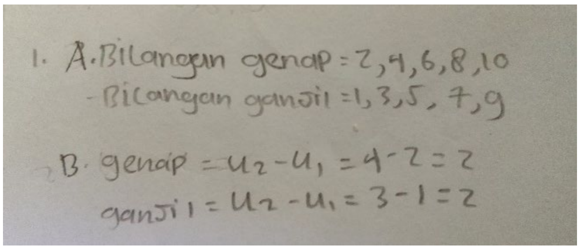


Figure 1. Student Answer Result Number 1

The image shows the answers of the students' work in the high category, who managed to answer correctly on number 1. The student was able to mention that there are 2 patterns of arithmetic rows correctly and mention the differences precisely.

Question Item 2

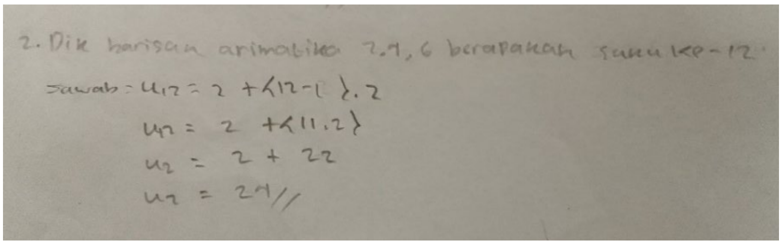


Figure 2. Student Answer Results Number 2

The picture shows the work of students with a high category, who were able to answer perfectly on number 2. Students can give examples of arithmetic rows according to the pictures in the question correctly.

Question Item 3

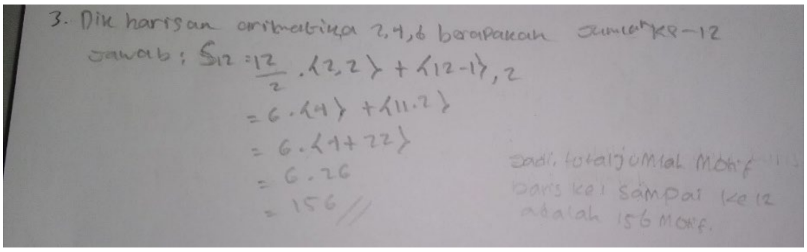


Figure 3. Student Answer Results Number 3

The picture shows the students' answers to question number 3, which are included in the high category because they can answer correctly. Be able to compile and deduce from a problem correctly for the number of n quarters.

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Question Item 4

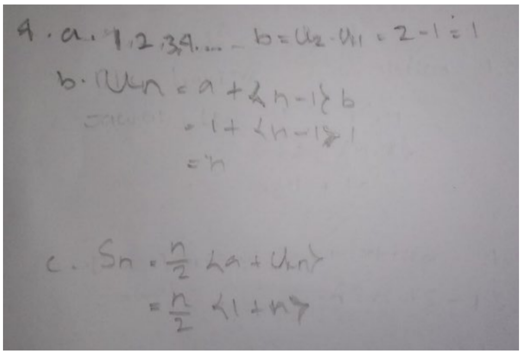

Figure 4. Student Answer Result Number 4

The picture shows the results of students' answers with a high category in question number 4, because students can give complete and correct answers to a problem with accurate solutions as a solution.

Question Item 5

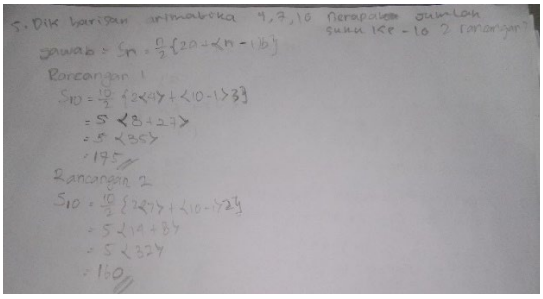

Figure 5. Student Answer Results Number 5

The picture shows the results of student work in the high category in question number 5. The student can apply the cultural context to the context of real problems and is able to solve them correctly according to the concept of arithmetic series.

Increasing Productive Disposition in Ethnomathematics-Based Learning

Based on the results of data analysis, the application of ethnomathematics-based learning has been proven to be effective in increasing *students' productive disposition.* There were positive changes in students' attitudes, interests, and beliefs towards mathematics learning after receiving an intervention that integrated the motif of Batik Mandalikan Banten. This improvement is not only seen from the results of a better understanding of concepts, but also from affective aspects such as confidence in solving problems, perseverance in learning, and appreciation for the relationship between local culture and mathematical concepts.

This is in accordance with the indicators of *productive disposition,* which include the view that mathematics is a reasonable, useful, and can be learned with the right effort; the habit of mathematical thinking, the courage to take academic risks, integrity, positive motivation, and *self-efficacy* towards mathematics. The integration of local cultures provides a context close to students' lives, so they feel more emotionally and cognitively engaged. Learning becomes more engaging and meaningful as students discover a direct relevance between the material being studied and their daily lives. Thus, ethnomathematics-based learning of the Batik Mandalikan Banten motif is not only contextually relevant but also effective in shaping students' positive character through increasing *their* productive disposition. Based on this, there is potential for ethnomathematics in mathematics learning which is able to improve students' mathematical abilities, besides that students are able to recognize the culture around them (Aini & Masykur, 2018; Fitriani, Somatanaya, Muhtadi, & Sukirwan, 2019; Gunawan & St.Suwarsono, 2019; Hasanuddin, 2017; Indriyani, 2017; Lusiana, Afriani, Ardy, & Widada, 2019; Maharani & Maulidia, 2018; Nisa, Nurjamil, & Muhtadi, 2019; Putra & Indriani, 2017; Sulistyani, Windasari, Rodiyah, & Muliawati, 2019; Wahyuni, Tias, & Sani, 2013).

CONCLUSION AND SUGGESTION

Based on the results of research at SMKS PGRI 3 Serang City, it was concluded that ethnomathematics-based learning of the Batik Mandalikan Banten motif was able to improve students' ability to understand mathematical concepts and *productive disposition* compared to conventional learning. In addition, the Batik Mandalikan Banten motif contains mathematical elements in the form of rows and arithmetic sequences that are proven to support the mathematics learning process in the classroom

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