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Ethnomathematics study of bamboo woven model in Yogyakarta based on *Liki design* matrix and tts integration in mathematics learning

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ABSTRACT

Liki design by Gerdes is a follow-up analysis of Lusona's painting layout using matrix principle. The result of Lusona is identical with Indonesian culture especially woven bamboo. This study aimed to analyze woven bamboo models in Yogyakarta based on Liki Design. Liki's design was a sand painting style which was analyzed by Paul Gerdes. It also described the integration of the results analysis in school mathematics. This research is qualitative with an ethnomathematics approach. The woven bamboo model was analyzed based on the stages of data collection through interviews, documentation and collection of audiovisual materials, data separation, data analysis using Liki design by determining the main motive, coding the weaving motif into the matrix, and to prove the validity of the results, an assessment was carried out between appraisers. Based on the results obtained from the analysis of 13 woven bamboo motifs, six corresponding matrix models. The integration of research results can be done in two ways, including context and content. As a context, the results of the analysis of woven motifs could be used to teach the context of matrix orders, number motifs, matrix operations, and geometric transformation, while integration in terms of content, research results can be used as content for mathematical exploration and technological literacy in the learning process.

INTRODUCTION

The Covid-19 Pandemic has given a new challenge to the education and learning aspect in Indonesia. Distance learning implementation as a learning alternative during Covid-19 encourages teachers to be able to manage distance classes through synchronous and asynchronous techniques (the General Director, 2020). Teachers and students have to adapt to the new temporary curriculum in learning due to the restriction aspect, learning strategy selection to include and engage with students' interaction to be meaningful learning, and monitor student learning development from home.

The Indonesian government released educational operational guidelines that are more meaningful to students, focusing on education, life skills, tasks and learning activities that consider situations, interests, and facilities (the General Director, 2020). Savery and McCullom stated that

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proper online learning implementation must be able to square up challenges and support which is in line with the activity of interesting issues recently, and online learning can be conducted in a learning environment which supports inquiry and student activity (Thobin, Mandernach, & Taylor, 2015). Consequently, teachers and students are required to be fast learners, able to provide strategies, innovative methods, meaningful or organized problems, as well as project-based learning activities to create a learning environment that supports inquiry and student activity.

One of the most suitable strategies is to implement contextual learning based on daily activity and social culture which is named ethnomathematics. This is compatible with ethnomathematics definitions as a way to explain the material, find out and understand mathematics through activity associated with social culture practiced by cultural groups around (D'Ambrosio, 1990; Marsigit, 2016; Rosa & Orey, 2011). This cultural context integration in mathematics learning has given a chance to students to seize proper mathematics learning and evaluation (Barton, 1996; Torres-Velasquez & Lobo, 2004). There are 3 types of culture that can be integrated into mathematics learning, first activities such as sorting, classifying, measuring, modelling, examining, resuming, problem-solving, encoding; second types of notions such as value, norm; and third types of artefacts or crafts such as visible and documented physical objects (Arismendi. 2001; Bishop, 1988). Ethnomathematics can be defined as a perspective that bridges formal mathematics and informal mathematics through critical analysis of cultural forms and activity. It was expected to embed cultural value in character and civilized national identity, develop a proper assessment for students, improve their conceptual understanding, mathematics literacy, mathematics problem solving, and mathematics utilization awareness in social and daily activity (Aprilyani, & Hakim, 2020; Barton, 1996; Laurens, 2016; Prayitno, 2016; Susilo & Widodo, 2018; Suwarsono, 2020; Torres-Velasquez, & Lobo, 2004; Wahyuni, Tias, & Sani, 2013).

The findings from studies on cultural forms in mathematics learning can be incorporated into the material as a supplement to activities that link mathematical content with realistic contextual elements, such as woven motif related to the area of a rhombus, ketupat related to the three-dimensional object of cuboids, weaving form, woven mat related to rectangular, Melayu's carving related to symmetry material, and Madura batik motif related to the relations of segment, symmetry, and angular relationships (Abi, 2016; Febriyanti, Kencanawaty, & Irawan, 2019; Wahyuni, & Pertiwi, 2017; Zayyadi, M, 2017). It shows that ethnomathematics study was dominated by study in Geometry subject.

Gerdes has analyzed cultural forms in a sand painting named *Lusona* through Lunda Design based on matrix characteristics. *Sona* or *Lusona* is a sand painting from the Chokwe tribe's tradition which is identical with Ngangela and Luchazy tribe's tradition (Gerdes, 1999, 2002). This tribe lives in Eastern Angola, North Western of Zambia, and bordering with Congo/Zaire. This tradition is related to *Mukanda* rites to commemorate the 6 until 8 months of a male baby. The place of Chokwe race's residents is also recognized as Lunda. In their daily life, the women of Chokwe tribes are farmers, while the men are hunting. When the men took a rest after hunting, they shared stories about the forms of sand painting, which were later called *Sona* or *Lusona*. There are various models of Sona or *Lusona* based on the stories of Chokwe tribes (Gerdes, 1999).

Liki design is an advanced analysis of *Lusona* conducted by Gerdes on her sister's birthday, who is named Likilisa. *Liki* design has an interesting character that corresponds to object layout and matrix principles of the *Liki* design analysis has concluded that matrix related to *Liki* design has well-organized motif obtained from several times multiplication of symmetrical matrix (Gerdes, 2007). This *Liki* design has similarities with Indonesian culture especially bamboo woven. Therefore, the bamboo woven motif in this research was analyzed using *Liki* design, henceforth the results will be developed in a mathematics school activity.

Education is an integrated and comprehensive process. The education process cannot be seen as a theoretical process but as practice. Theories in learning material are packed to be implemented to solve and observe phenomena around. Ethnomathematics has a big role in the implementation of learning by considering the background of the student's environment that can be practically integrated into the curriculum (Machaba, & Dhlamini, 2021). Various ethnomathematical studies were carried out as a form of support in connecting the mathematical concepts studied with the students' environmental backgrounds. Various ethnomathematical studies explain the relationship between the concepts of basic calculations in mathematics, namely numbers and number operations

in *Marosok* buying and selling activities in West Sumatra (Nurjanah, Mardia, & Turmudi, 2021), the calculation of the seasons and the Javanese calendar on the anniversary of death and birth involving mathematical models (Prahmana, Yuniato, Rosa, & Orey, 2021; Sulistyawati, 2019), the process of making *Barongko* cake which involves the concepts of congruence, similarity, division, three-dimensional geometric shape (Pathuddin, Kamariah & Nawawi, 2021), *Lammang* cake shape as a representation of a constant function rotated about the x or y-axis (Busrah, & Pathuddin, 2021).

This research was conducted to analyze woven bamboo models in Yogyakarta based on *Liki* Design. *Liki* Design was a sand painting design which was analyzed by Paul Gerdes. This study also described the integration of the analysis of the results in school mathematics. Therefore, this study is expected to help the students or even the society to aware of mathematics exists in the trend of study around their places. This research is also conducted based on mathematics theory and design founded by a mathematician named matrix analysis in *Lunda* design.

METHODS

This research is qualitative research with an ethnography approach. This research analyzed mathematics elements from various woven motifs using analysis principles in *Liki* designs and their implementation in mathematics school. The research instrument is the researcher who collected data of various bamboo woven motifs, analyzed bamboo woven motifs based on the *Liki* design matrix in mathematics, and integrated bamboo woven analysis results into the mathematics school curriculum. This is in line with the characteristic of qualitative research stated by Creswell, Hatch, Marshall and Rossman (Creswell, 2014) that the researcher is the primary instrument in qualitative research. To obtain data related to various bamboo woven motifs, the researcher collected data through interviewing the research subject and documenting the research object, while to obtain data related to mathematics analysis results of the bamboo woven motif in mathematics school curriculum was used focus group discussion activity with mathematics education experts. Figure 1 shows the research procedure of this study.

The research data were obtained from bamboo woven craftsman in Sidomulyo village, Kulon Progo residence as the main source. The subject was selected according to the popularity and capability of the craftsman proven by several news reports on the newspaper or internet (Hidayat, 2016; Utomo, 2016). Data sources for this research are photos and videos of the bamboo woven production process by the subject that are documented as bamboo woven motif design pictures. The next process was to window the data this process analyzed to determine the main pattern of bamboo woven motif according to production technique and process for each woven model. In analyzing the data, the researcher analyzed the data by analyzing bamboo woven motifs to determine the corresponding matrix. Each corresponding matrix was analyzed based on the *Liki* Design Matrix. To acquire valid data, inter-rater assessment by ethnomathematics and algebra two experts was applied. Based on the results of the inter-rater assessment, it can be known the percentage of the experts' agreement for the bamboo woven model analysis result using *Liki* Design Matrix.

FINDINGS

There are 13 bamboo woven motifs analyzed using *Liki* Design Matrix. The first stage of this research is to determine the 13 bamboo woven motifs based on the main pattern. The main pattern on each bamboo woven motif is a repetitive pattern by applied translation, reflection, and dilatation. Figure 2 shows an example of a woven pattern which corresponds to its main pattern.

To simplify the analysis process, the bamboo slats were separated into yellow slats representing 0 numbers and brown slats representing 1 number. The example of a woven pattern that corresponds to its main pattern is shown in Figure 3. In the next process, the corresponding matrix was analyzed based on the *Liki* Design Matrix analysis by Gerdes. Figure 4 shows an example of *Liki* Design with order 6x6 and its corresponding matrix.

According to Figure 4, the area of black squares is related to matrix component valued 1, whereas the area of white squares is related to matrix component valued 0. If the matrix corresponded with *Liki* Design above is matrix B, next matrix B was operated, so that attained form of B^2, B^3, B^4, and so forth. Thus, the matrix operation result is shown in Figure 5. Based on the operation results of matrix B, it can be known that the diagonal of B^2 and B^4 formed a consistent pattern of repetitive matrix components as shown in Table 1.

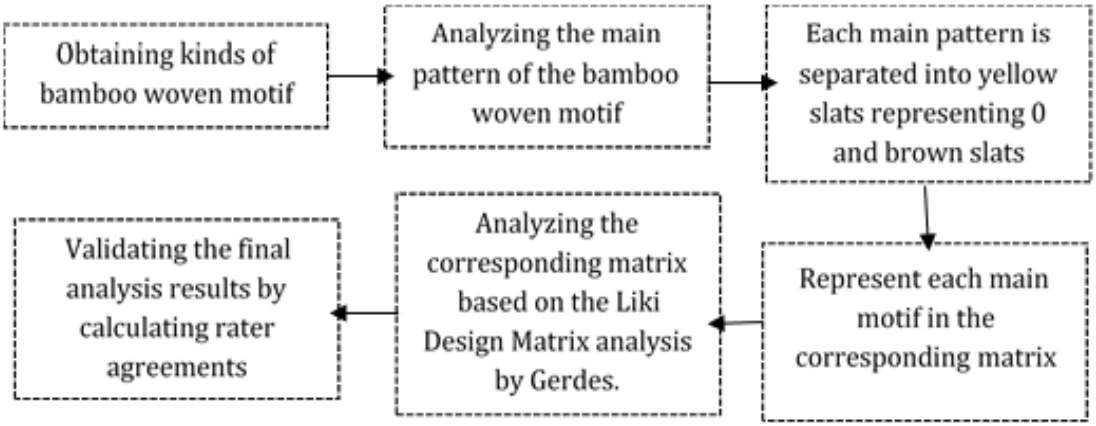


Figure 1. Research Procedure Diagram

Figure 2. Woven motif and main pattern

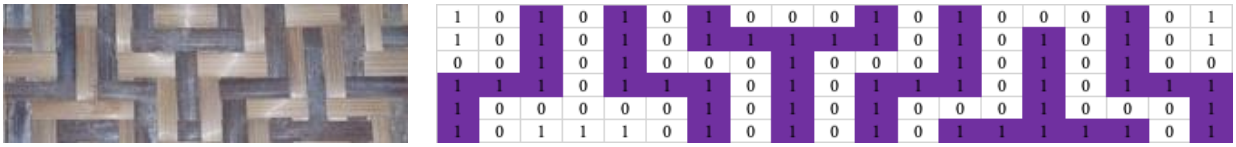
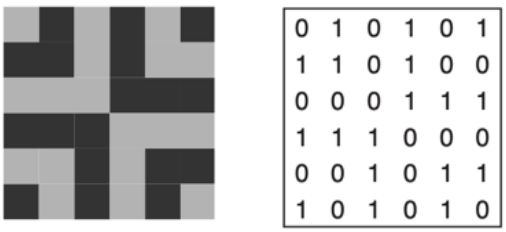


Figure 3. Main pattern and its corresponding matrix



0	1	0	1	0	1
1	1	0	1	0	0
0	0	0	1	1	1
1	1	1	0	0	0
0	0	1	0	1	1
1	0	1	0	1	0

Figure 4. *Liki* Design order 6x6 and its corresponding matrix

3	2	2	1	1	0
2	3	1	2	0	1
2	1	3	0	2	1
1	2	0	3	1	2
1	0	2	1	3	2
0	1	1	2	2	3

$\mathbf{B}^2$

3	6	2	7	3	6
6	7	3	6	2	3
2	3	3	6	6	7
7	6	6	3	3	2
3	2	6	3	7	6
6	3	7	2	6	3

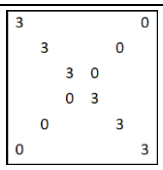
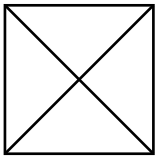
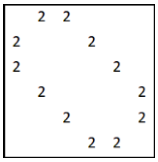
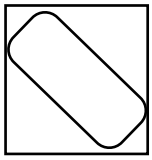
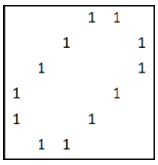
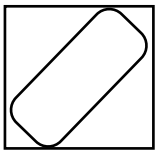
$\mathbf{B}^3$

19	16	16	11	11	8
16	19	11	16	8	11
16	11	19	8	16	11
11	16	8	19	11	16
11	8	16	11	19	16
8	11	11	16	16	19

$\mathbf{B}^4$

Figure 5. Operation result of matrix B

Table 1
Matrix Exploration to Obtain Cyclic Pattern

Matrix	Cyclic Pattern
	
	
	

The exploration of this matrix multiplication resulted an even powered form of the matrix that will form a different cyclic structure (see Figure 6a) with matrix multiplication of odd powered forms of the matrix (see Figure 6b). Based on matrix encoding and operation, it acquired 6 models which corresponded to 13 bamboo woven motifs.

Model 1 in Figure 7, if the matrix corresponded to a bamboo woven motif several times multiplied, matrix result form of its multiplication will have similar characteristics as follows a) the first row of a component equal to the first column of component, b) the last row of a component equal to the last column of component, c) diagonal component is symmetrical to the center of the matrix, and d) components around the diagonal are symmetrical to matrix diagonal. Model 2 of woven motif analysis results show if the matrix corresponded to bamboo woven motif several times multiplied, matrix result form of its multiplication will have similar characteristic as follows a) the first row of a component equal to the last row of component, b) diagonal component is symmetrical to the center of the matrix, c) components around the diagonal are symmetrical to matrix diagonal.

Model 3 is the next model has the different characteristics with the previous models. Model 3 of woven motif analysis results show if the matrix corresponded to bamboo woven motif several times multiplied, matrix result form of its multiplication will have similar characteristics as follows a) the components are symmetrical to row and column number 9, b) the diagonal component is symmetry based on reflection rule to diagonal, and c) components around diagonal are symmetrical to row and column number 9. The analysis result of the motif based on *Liki* Design in the Figure 9 is similar to the other motif as shown in the Figure 10.

To analyze a rectangular matrix like Figure 9, define a transpose matrix and then multiply by its origin matrix thus it forming a square matrix. This matrix is analyzed using *Liki* Design. If the matrix corresponded to a bamboo woven motif several times multiplied, matrix result form of its multiplication will have similar characteristics as follows: a) matrix components are symmetrical to one of the matrix diagonals, b) matrix components around the diagonal are symmetrical to matrix diagonal. Then, to analyze a rectangular matrix like Figure 12, define a transpose matrix and then multiply to its origin matrix thus it forming square a square matrix. This matrix is analyzed using *Liki* Design. If the matrix corresponded to a bamboo woven motif several times multiplied, matrix result form of its multiplication will have similar characteristics as follows a) matrix components on the diagonal are symmetrical to the center of the matrix, b) components around diagonal are symmetrical to main diagonal, c) the first 3 rows of the matrix are equal with the last 3 rows of the matrix, d) components on the third until fifth rows formed flower petals like pattern.

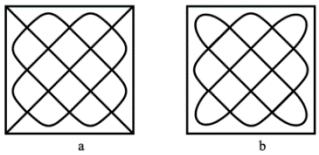


Figure 6. Cyclic structure of the even and odd powered matrix

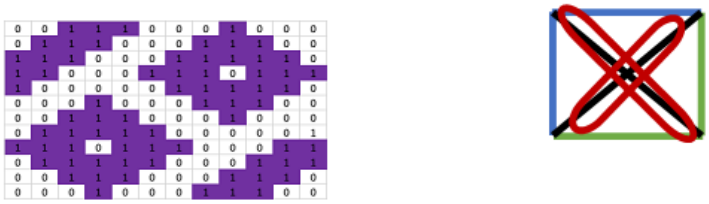


Figure 7. Model 1 woven motif analysis result based on *Liki* Design

Figure 8. Model 2 woven motif analysis result based on Liki Design

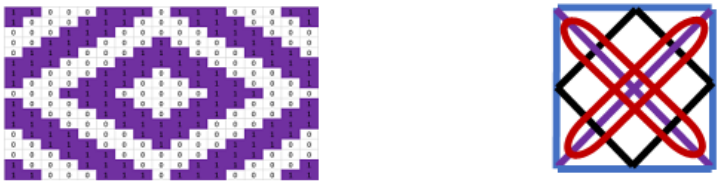


Figure 9. Model 3 woven motif analysis result based on *Liki* Design

Figure 10. Model woven motifs analysis result based on *Liki* Design Correspondent to Model 3

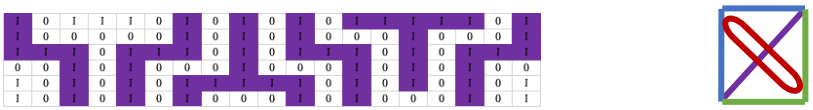


Figure 11. Model 4 woven motif analysis result based on the *Liki* Design

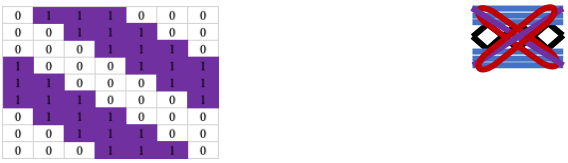


Figure 12. Model 5 woven motif analysis result based on *Liki* Design

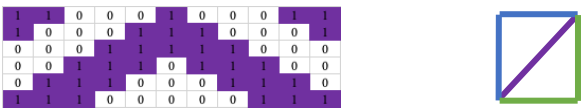


Figure 13. Model 6 woven motif analysis result based on Liki Design

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Rater1 * Rater2	13	100.0%	0	0.0%	13	100.0%

Symmetric Measures

		Value
Measure of Agreement	Kappa	.[a]
N of Valid Cases		13

a. No statistics are computed because Rater1 and Rater2 are constants.

Figure 14. Kappa Measurement Agreement Result

To analyze a rectangular matrix-like Figure 13, define a transpose matrix and then multiply by its origin matrix thus it forming a square matrix. This matrix is analyzed using *Liki* Design. If the matrix corresponded to a bamboo woven motif several times multiplied, matrix result form of its multiplication will have similar characteristics as follows: a) the first row of a component is equal to the first column of the component, b) the last row of a component equal to the last column of component, c) matrix components on one of the diagonals are symmetrical to the center of the matrix. Based on the research result above, analysis of matrix corresponded to bamboo woven motif can be integrated into mathematics learning activity in school. The result of data analysis regarding bamboo woven motif linkages with *Liki* Design were validated by 2 rater using rater agreement assessment sheet. The assessment used dichotomous answer questionnaire consist of agree and disagree choices. This research results were analyzed using Kappa Measurement Agreement which obtained Kappa score 1. It means that the analysis result of the 13 bamboo woven motifs regarding *Liki* Design were agreed by rater.

The integration could be conducted on 2 subjects, mathematics context, and as mathematics content. The analysis results can be applied to matrix order context, operation of the matrix, pattern number, and geometry transformation context. Here are content examples of bamboo woven motif analysis results applying the *Liki* Design Matrix.

Matrix order content integration in Table 2 has bolstered the implementation of Permendikbud No. 37 tahun 2018 (Minister of Education and Culture of Republic Indonesia, 2018), especially on class XI semester 1 mathematics learning activity where the students shall be able to explain matrix using contextual problem. Matrix which correspond to bamboo motif could be used to example of matrix implementation in daily life. Through the process of coding the motifs that correspond to the color of the bamboo blades and numbers, students can determine the appropriate matrix for the motif being analyzed. On another content, this research result can be expanded as follows:

Table 2
Implementation of analysis results on the matrix order content

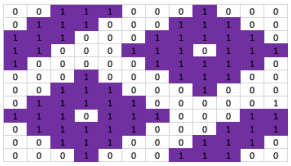
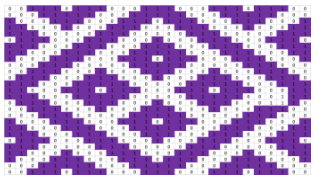
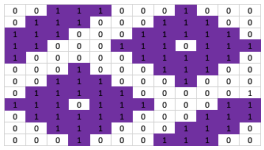
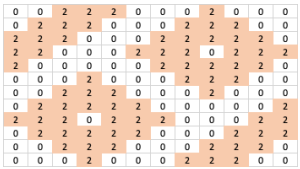
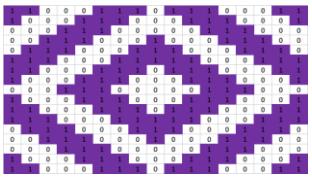
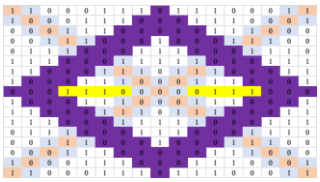
Woven motif	Corresponding matrix order
	12 × 12
	27 × 27

Table 3
Implementation of analysis result on operation content

Woven motif	Matrix operation	Conclusion
		The summation operation of its matrix would not alter the bamboo woven motif
		A multiplication matrix with its matrix would not alter diagonal character and components in the matrix.

Matrix operation content integration on in Table 3 above has bolstered the implementation of Permendikbud No. 37 tahun 2018 (Minister of Education and Culture of Republic Indonesia, 2018), especially in class XI semester 1 mathematics learning activity where the students shall be able to calculate matrix operation consist of summation, subtraction, scalar multiplication, and transpose using contextual problem. The learning activity can be start with matrix operation on the matrix with ordo 2x3 or 3x3. The next step, to assist student calculates matrix operation, the teacher can use several software to aid the calculation such as Microsoft Excel and Wolfram Alpha. This technology integration will enable student to calculate matrix operation in higher ordo using real life context such as bamboo woven motif. These activities can be developed into pattern number content as presented in Table 4. Pattern number content integration on in Table 4 has bolstered the implementation of Permendikbud No. 37 tahun 2018 (Minister of Education and Culture of Republic Indonesia, 2018) especially on class XI semester 1 mathematics learning activity where the students shall be able to analyze factual knowledge, procedural and conceptual based on curiosity about science, art, culture, technology, and humanity.

Geometry transformation content integration in Table 5 has bolstered the implementation of Permendikbud No. 37 tahun 2018 (Minister of Education and Culture of Republic Indonesia, 2018) especially in class XI semester 1 mathematics learning activity where the students shall be able to analyze and compare transformation as well as transformation composition using matrix.

Table 4
Implementation of analysis result on the pattern number content

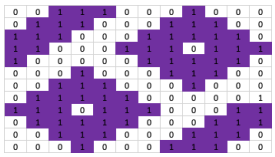
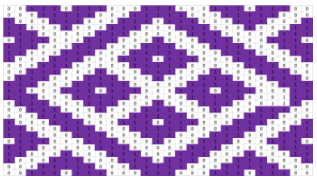
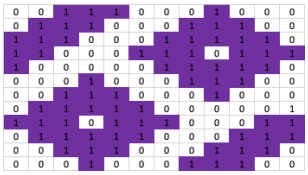
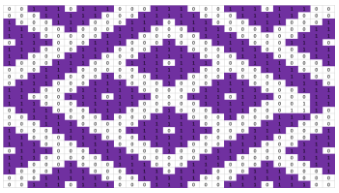
Woven motif	Conclusion
	a. the first row of the matrix is equal to the first column of the matrix b. the last row of the matrix is equal to the last column of the matrix c. the diagonal component is symmetrical to the center of the matrix d. components around the diagonal are symmetrical to the matrix diagonal
	a. matrix diagonals are corresponded based on the reflection rule to the row number 14 as well as the column number 14. b. matrix components around the diagonal are corresponded based on the reflection rule to the row number 14 as well as the column number 14. c. matrix components with purple color are corresponded based on the reflection rule to the row number 14 as well as the column number 14.

Table 5
Implementation of analysis result on the geometry transformation content

Woven motif	Matrix operation	Conclusion
		The main pattern translated as far as 5 units up then 5 units to the right
		The main pattern rotated with a certain point as far as 90 degrees or 180 degrees or 270 degrees.

DISCUSSION

Besides the integration of analysis results as context, analysis results can be integrated into mathematics content as mathematics exploration and technology literacy content. Ethnomathematics can be an integrated component in mathematics education through the application of culture as a starting point for learning mathematics. The form of culture is used in the mathematics learning curriculum through an analytical process in adjusting the cultural context to the material so that it can bring up the process of students' mathematization to be a meaningful learning (Palhares, 2012; Widada, Herawaty, & Lubis, 2018; Zhang, & Zhang, 2010). The use of cultural context in learning mathematics is an effort to provide knowledge to students that mathematics and culture are a connected unit. (Irawan, & Kencanawaty, 2017). According to Minister of Education and Culture Regulation number 37 (2018), Core Competency related to exploration stated on Core Competency number 3 (knowledge) and Core Competency number 4 (Skill). These competencies in mathematics subject for secondary high school are aimed at understanding, implementing, analyzing factual knowledge, conceptual, procedural to solve problems as well as the ability to process and reason related to the development of the learning material in school independently using the proper method. This competency can be achieved by exploration activity.

Here are examples of the learning phase which contains mathematics exploration activity by implementing Lunda Design analysis results: observing bamboo woven motif around the students, representing matrix based on its bamboo woven motif, observing the pattern number on each

component of matrix representation, calculating matrix operation, observing similarity and difference of pattern number before to operating as well as after operated, and drawing conclusion of activity related to the characteristic of pattern number. By the way of this activity, students can interact with the environment and analyze the pattern or consistency of the contextual problem. Another example of a mathematics exploration activity that implements Lunda Design analysis results as follows: observing bamboo woven motif around the students, representing matrix based on its bamboo woven motif, implementing geometry transformation to create a new and different motif, and observe the characteristics and pattern related to the similarity and difference of the new bamboo woven motif with the prior motif.

Two examples above can be developed into another mathematics exploration activity, such that the student will be able to develop, reason, process, and create new opus using their mathematics knowledge. Viewed from technology literacy content, calculator utilization not so long ago was sometimes restricted or even forbidden in the mathematics learning activity. However, this perspective has changed as the calculator utilization nowadays instead as the primary tool for students to explore mathematics learning activities (Doerr, & Zangor, 2000; McCulloch, Hollebrands, Lee. Harrison, & Mutlu, 2018; Parrot, & Leong, 2018). There found various modes of mathematics calculators such as *Ms. Excel*, *GeoGebra*, *SymboLab,* and *Wolfram Alpha*. In the previous section, it has been explained that mathematics exploration activity is an important activity to fulfil basic competency in the curriculum, as a tool to develop reasoning and skills such that the student will be able to apply their knowledge to solve the contextual problem. To support mathematics exploration activity, the mathematic calculator can be deployed as a primary assistance tool to the student such that the student did not only think about "how to count" instead "how it become like this? or how it can be?". An example of mathematics calculator utilization in mathematics exploration activity is in fraction material. If the numerator is constant and the denominator increases, does the value increase or decrease?

Mathematics calculator utilization in mathematics exploration activity oriented to the bamboo woven motif and Lunda Design can be seen as presented in Table 6. Based on Table 6, it can be discovered that mathematics exploration activity using bamboo woven context based on Lunda Design can be conducted by utilizing exploration tools such as *Ms. Excel*, *GeoGebra*, *SymboLab*, *Wolfram Alpha*, and so forth.

The research results provide creative ideas for teachers in carrying out meaningful and creative mathematics learning. Online mathematics learning, as a result of the Covid-19 Pandemic, requires teachers to use various interesting learning techniques, one of which is using contexts that are close and meaningful to students. Some of the teacher's creative ideas during online learning include the use of the context of the Covid-19 effect in lectures to analyze the agreement through an inter-rater reliability assessment, the use of ethnomathematics contexts in learning to improve digital literacy skills, and various other creative exploration activities (Sulistyawati, & Rahayu, 2022; Sulistyawati, 2021). In addition to the use of a meaningful context, it is necessary to apply learning aids in the learning process as a medium for delivering remote messages that can be accessed easily, cheaply, and effectively, such as GeoGebra, Ms. Excel that can support faster computational, literacy and mathematical calculation skills (Sulistyawati, & Rahayu, 2022; Sulistyawati, 2019).

The importance of using cultural contexts in learning mathematics provides opportunities for educators to conduct experiments and research. The use of cultural contexts in mathematics has been applied and has had a positive impact on learning mathematics, namely being effective on mathematics learning achievement, interest in learning, students' appreciation of mathematics, students' mathematical literacy skills which include communication, modelling, representation, reasoning and argumentation, problem-solving, symbols and formalism and mathematics tools, appreciate their cultures more and can take values within them, which impact on the formation of

Table 6
Technology literacy content on the woven motif analysis process

Mathematics exploration activity	Applicable tool
a. Observing bamboo woven motif around the students **b.** Representing matrix based on its bamboo woven motif **c.** Observing the pattern number on each component of the matrix representation **d.** Calculating matrix operation **e.** Observing similarity and difference of pattern number prior before operated as well as after operated **f.** Drawing conclusion of activity related to the characteristic of pattern number	Ms. Excel using formula =MMULT, =SUM, = X-X, etc 
a. Observing bamboo woven motif around the students **b.** Representing matrix based on its bamboo woven motif **c.** Implementing geometry transformation to create new the new and different motif **d.** Observing the characteristic and pattern related to similarity the similarity and difference of new the new bamboo woven motif with the prior motif	*GeoGebra* using menu *rotate,* reflect, translate.

national character (Kiptiyah, Purwati, & Khasanah, 2021; Nur, Waluya, Rochmad., & Wardono, 2020; Setiana, 2020; Sulistyawati, 2020; Sunzuma, Zezekwa, Gwisangwe, & Zinyeka, 2021; Vitoria, Monawati, Fauzi, & Mislinawati, 2021).

Skills in using contexts related to culture are accompanied by the ability of teachers to integrate them into learning. Sunzuma & Maharaj mention that the challenges of teachers in applying ethnomathematics, especially in learning geometry, include the lack of knowledge of learning approaches/methods that can integrate cultural contexts, and how to integrate these approaches into the teaching of geometry (Sunzuma, & Maharaj, 2019). Based on this research, it can be seen that it is important to have teacher training on how to integrate culture into the mathematics learning curriculum (Budiarto, Artiono, Setianingsih, 2019). To construct mathematics learning with a contextual approach based on local culture, several activities must be carried out, namely registering existing forms of local culture, conducting assessments of competency standards and basic competencies that are under local cultural forms, and determining the relationship between local cultural forms and basic competencies, describing competency standards and basic competencies are indicators of competency achievement that can be measured, compiling local culture-based lesson plans, compiling student worksheets, preparing learning media and teaching aids that support the implementation of mathematics learning with a contextual approach based on local culture (Sulistyawati, 2018). Through the results of research on the study of bamboo woven, it is hoped that it can provide a repertoire of cultural forms that can be integrated into learning and its relationship to basic competencies in the school mathematics curriculum in Indonesia.

CONCLUSIONS

Based on the research results, it can be concluded several things, there are 13 models of woven bamboo in Yogyakarta whose models will be analyzed based on the Liki Matrix Design. Based on the analysis of the bamboo woven model using Liki Design matrix, 6 matrix models were obtained. The integration of the analysis results of the woven bamboo model based on Liki Design matrix can be done in two ways, namely integration as context and integration as content. In terms of integration as a context, the results of the analysis of the woven bamboo model can be used as a context for

matrix size/order, number patterns, matrix operations, and geometric transformations involving matrices. Meanwhile, in terms of integration as content, the results of the analysis of the woven bamboo model can be used as content for mathematical exploration and technological literacy content in the learning process. The results of this study can be used as a reference for learning mathematics that uses a cultural context, especially in matrix learning. Other cultural forms that can be integrated into mathematics learning can be studied further to enrich studies on ethnomathematics.

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