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ETHNOMATHEMATICS: DESIGN OF SABUK TRADISIONAL (KERU) BAJAWA AS A LEARNING MEDIA FOR ELEMENTARY SCHOOL

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Abstract

Teaching and learning can be successful and meaningful if it uses a design that is close to students, namely the cultural context. This study aims to explore the mathematical content of the sabuk tradisional in the saboweki/traditional clothing of the Bajawa ethnic community, East Nusa Tenggara Province. The research method used descriptive qualitative with an ethnographic approach. Research object was sabuk tradisional Bajawa (keru). The data was collected through observation and documentation, while the source triangulation technique used to obtain the validity of the data. Data analysis techniques started from exposure, reduction and conclusion. The results showed that sabuk tradisional (keru) bajawa contains mathematical concepts including number patterns, multiplication as repeated addition, geometry and measurement and reflection. The findings of this study could improve the quality of learning in elementary schools through the sabuk tradisional (keru) bajawa as a mathematics learning media based culturally responsive.

Keywords: Saboweki, Keru, Bajawa, Math Learning, Ethnomathematics.

Abstrak

Proses belajar mengajar dapat berhasil dan bermakna jika menggunakan desain yang dekat dengan siswa, yaitu konteks budaya. Penelitian ini bertujuan untuk mengetahui kandungan matematis sabuk tradisional pada saboweki/pakaian adat masyarakat suku Bajawa Provinsi Nusa Tenggara Timur. Metode penelitian yang digunakan adalah deskriptif kualitatif dengan pendekatan etnografi. Objek penelitian adalah sabuk tradisional Bajawa (keru). Pengumpulan data dilakukan melalui observasi dan dokumentasi, sedangkan teknik triangulasi sumber digunakan untuk memperoleh keabsahan data. Teknik analisis data dimulai dari pemaparan, reduksi dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa sabuk tradisional (keru) bajawa mengandung konsep matematika yang meliputi pola bilangan, perkalian sebagai penjumlahan berulang, geometri dan pengukuran dan refleksi. Temuan penelitian ini dapat meningkatkan kualitas pembelajaran di sekolah dasar melalui sabuk tradisional (keru) bajawa sebagai media pembelajaran matematika berbasis budaya responsif.

Kata Kunci: *Saboweki, Keru, Bajawa, Pembelajaran Matematika, Etnomatematika.*

INTRODUCTION

The purpose of education is to educate people to be cultured, so that learning in the classroom can also be said as a process of cultural transformation (Zafi, 2018; Syafaruddin, 2017; Harianto *et al.,* 2020). Learning is a life value process to get a meaningful and cultural experience (Ahsani *et al.,* 2021). So, the challenge of education now is to maintain a set of cultural values that are important for the sustainability of a cultural community in the midst of the cultural influence of globalization (Ubiratan D'Ambrosio & Ascher, 1994; d'Ambrosio, 1985; D'Ambrosio, 2008; U D'Ambrosio & D'Ambrosio, 2013). Therefore, the process of cultural transformation must also be an important emphasis in learning mathematics. The learning environment will be directed at achieving the goal of preserving culture and linking learning materials with real-life experiences (Rahayuningtyas *et al.,* 2021).

The problem in learning mathematics at elementary schools is the lack of active involvement of students, rigid and far from socio-cultural, even though mathematics comes from ideas, ways, and human techniques to respond to their environment (Prahmana *et al*, 2021; Noor, 2020). In addition, mathematics in schools is not based on culture and not contextual with students' daily lives.

It has an impact on the thinking and reasoning abilities of students who are low in solving math problems in real life (Rosa & Orey, 2011; Prahmana, 2020). Teachers should be able to design mathematics teaching materials according to the conditions and environment of students. Because teaching materials serve as guidelines for teachers in carrying out the learning process in the classroom (Ahsani, 2020). Teachers can choose teaching approaches, strategies or media to help students learn mathematics (Supriadi & Arisetyawan, 2020; Setyawan, 2020).

The current implementation of the 2013 curriculum, the goal of learning mathematics is mastery of mathematical concepts and their application in the student environment (Nurdyansyah, 2019; Karyoto *et al.,* 2020), Thus, linking mathematical concepts according to the cultural diversity of students can be used to achieve this goal. This is because students have different cultural backgrounds and the ability to acquire mathematical concepts differently. Mathematical concepts encountered in a culture are known as ethnomathematics. Ethnomathematical exploration contributes to both monoculture and multicultural classes in a class from a variety of cultures (Bito *et al.,* 2020; Hastuti & Setyawan, 2021).

Learning requires teachers to effectively use contextual, cultural, and ethnic learning resources as a challenge for modern society (Setyawan & Nawangsari, 2021). The ethnomathematical approach is one of the tools needed to mobilize these resources to build a constructive inquiry-based mathematics learning process. Mathematics learning in elementary schools is an ethnomathematical approach capable of presenting a contextual atmosphere so that learning is much more meaningful. Contextually obtained from the phenomenon or picture of the culture in accordance with the concept of learning. Thus, students are able to construct their own knowledge related to concepts because they are in direct contact with their own culture.

Ethnomathematics approach, teachers can teach mathematics cultural context in the classroom. The teacher gives an example by mentioning the students' cultures and provokes their curiosity. Teachers must know and enrich their own knowledge about the culture. so, it can answer students' curiosity. Furthermore, the teacher guides students to recognize and interpret each cultural element, develop construction procedures and make conclusions based on their observations (Verner *et al.,* 2019). In the end, the results of learning mathematics

include knowledge, skills, and attitudes, which form the content of mathematics learning competencies in a cultural context.

Several cultures have been studied including traditional games, traditional houses and musical instruments. The findings, this cultural research can be applied in learning mathematics at elementary schools. For example, traditional Bajawa games such as *wela maka* (playing top gasing), *mae po* (congklak), *wi oto* (cars), *mae dhara* (marbles); *dhao bure* (play rock); *mae moria* (some areas in Indonesia are called *benthik/patil lele*), *jedhe leke* (engklek) and many other types of games.

These games are rich in mathematical phenomena which, based on the results of research, these games have been successfully implemented as a context for learning mathematics with a Realistics Mathematics Education approach. (Jaelani *et al.,* 2013; Kaune *et al.,* 2013) In playing traditional games, children experience an informal measurement process using measuring tools such as *la* (step), *zepa* (fathom), *paga* (span) and *kungu* (finger). Traditional games like *wi oto* (Pull *oto*, *oto*= children's toy cars Bajawa) also has the phenomenon of up and down goods/passengers has proven to be a good context in starting learning addition and subtraction operations with a Realistic Mathematics Education approach (Herry Setyawan *et al.,* 2019; Kairuddin & Darmawijoyo, 2014).

Previous research was an ethnomathematical exploration of traditional houses. The results of the research were the architecture of making traditional houses in geometric shapes such as triangular prisms on the roofs of *sao*, *bhaga* and conical shapes on *ngadhu*. *Sao, ngadhu, bhaga* as well as various symmetrical carving ornaments. Symmetry can also be found in the shapes and patterns of traditional Bajawa. Wewe & Kau (2019) conducted a literature review related to the study of symbols in Bajawa culture and concluded that Bajawa cultural symbols such as *Ngadhu* (representation of male ancestors) dan *Bhaga* (representation of female ancestors) very closely related to geometry material at school. Bito & Fredy (2020) explained that the musical accompaniment of the dance *Ja'i* (BajawanesseTraditional Dance) is a good medium for learning circles and curved side space geometry such as tubes, cones and hemispheres.

Previous research has not revealed the results of exploration on the weaving of Bajawanesse traditional clothing. In fact, if this is done, it can increase the choice of using culture in improving the quality of mathematics learning in elementary schools. The recommendation of the Indonesian government that every Thursday, students wear uniforms made from woven with regional motifs, then this woven culture is used as material or media in learning mathematics. Bajawa woven motifs, for example: *luka*, *lue*, *sapu*, *keru* have geometric patterns and shapes, both two-dimensional and three-dimensional. Bajawa traditional clothes are worn during traditional ceremonial events with various motifs, but the most dominant is the horse motif (*jara*) and gold jewelry ("*bela*").

The activity of weaving cultural heritage is passed down from generation to generation in the traditional way of the Bajawa ethnic community as a necessity for clothing. A set of traditional Bajawa clothing is called "*saboweki*". Saboweki also used traditional events and dances. Traditional clothing has motifs with certain values or meanings for the education of students (Muda, Sadipun & Dole, 2020). Researchers limit this research to one field of study, namely sabuk tradisional *keru*. The purpose of this research is to explore ethnomathematics on the sabuk tradisional. The results of this study can be used as an alternative media for learning mathematics in elementary schools based on cultural responsiveness.

METHODS

The research method used descriptive qualitative with an ethnographic approach. Research object was sabuk tradisional Bajawa (*keru*). The data was collected through observation and documentation, while the source triangulation technique used to obtain the validity of the data. Data analysis techniques started from exposure, reduction and conclusion.

The researcher acts as the main instrument. Data were collected through observation and documentation. Triangulation technique was used to obtain data validity. Data analysis starts from exposure, reduction and conclusion. Relevant data collected is processed by observing motifs, patterns and other relevant matters and their relationship to mathematical concepts as well as competency standards and basic mathematics competencies in elementary schools.

This research has not yet reached the stage of extracting the process of producing *Keru* (weaving process), but only observing the *Keru* that has been finished and used by the community in traditional events. it is used by the Ja'i dancers during the welcoming ceremony. Ja'i is a traditional dance of the Bajawa ethnic community, NTT.

RESULTS AND DISCUSSION

Learning to be more interesting and meaningful for students is to include ethnomathematics as content and media in the learning process. Ethnomathematics is a link between culture and mathematics. The ethnomathematical approach is believed to be able to solve problems in learning mathematics (Cimen, 2014). Ethnomathematics in learning mathematics is a way to make mathematics interesting for students because it is taught using cultural contexts with their daily lives. Bajawa culture can be traced to a mathematical element called a belt *keru*.

One of the equipment "*Saboweki*" is a belt, in the Bajawa local language it is called *keru*. The following figure 1.

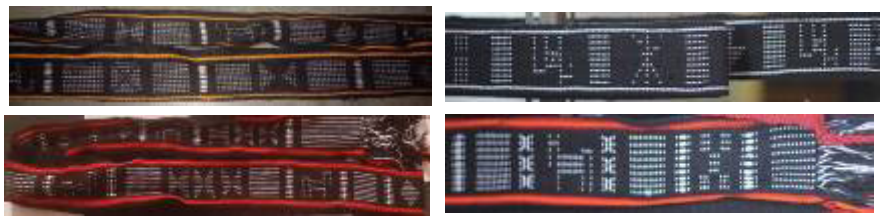


Figure 1: Some examples of Bajawa traditional belts (*Keru*).

There are many keru motifs (figure 1) that are found depending on the creations of the weavers. But the motive that is always present in every keru is a motive "*kuda*" and gold jewelry motifs ("*bela*"). Each motif has its own philosophical meaning as following figure 2.

(a) (b) (c) (d)

Figure 2: Horse Pattern (a,b,c) and gold jewelry (*bela*) (d) on some "*keru*"

The horse motif symbolizes the representation of ancestral presence, purity, authority, intelligence, strength and hard work. The horse motif is symbolizing the representation of "*bela*" which symbolizes prosperity.

Based on observations of a sample of 4 traditional belts "*keru*" found some mathematical concepts in keru (figure 1). The research results discussed in this article are limited to mathematical concepts in "keru" which is in elementary school mathematics material.

The mathematical concept of the traditional belt of the Bajawa Ethnic community can be explained in detail below.

a. The Concept of Multiplication as Repeated Addition

Curriculum 2013, the concept of multiplication was first introduced to grade 2 elementary school students after learning addition. Piaget said, children aged 6-12 years still think concretely, while multiplication material is an abstract mathematical concept. Therefore, students of this age need a bridge between their concrete experience and formal mathematics. This stage can be done in multiplication learning using the sabuk traditional *Keru* media, namely planting basic concepts and developing skills. The planting of basic concepts can be done by observing directly the sabuk traditional *keru* and then counting each observed point by adding it up repeatedly. This can help students construct their own informal knowledge.

One concrete experience of students in Bajawa NTT is the cultural experience of seeing or wearing traditional clothes (*saboweki*). One of the components or equipment of "*saboweki*" is "*keru*". The patterns *keru* are dominated by dots arranged in the form of a rectangular matrix as in Figure 3. These patterns are often observed by students, so that they have schemas about informal mathematics embedded in their cognition.

Patterns of arrangement of dots on "*keru*" observed when students see or use the belt will form a mental imagery which becomes the initial knowledge of students when they will learn multiplication. Objects arranged in a certain pattern will make it easier for students to understand the concept of multiplication as a repeating number.

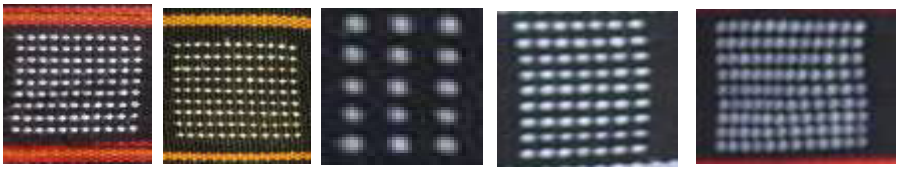


Figure 3: Pattern arrangement of points in a rectangular matrix

The dot patterns on *keru* as shown in Figure 3 are good media for learning the concept of multiplication as repeated addition. The dotted motif *Keru* can be used for the commutative property of multiplication mxn=nxm. In addition to the concept of multiplication, *keru* can also be used as the concept of multiples of a number (such as multiples of 3, multiples of 7 and multiples of 9).

The concept of multiples of numbers is a concept taught by elementary school students after learning the concept of multiplication. Mastery of this concept is very important for students of elementary school because it is useful for them both in learning advanced mathematics material and its application in everyday life.

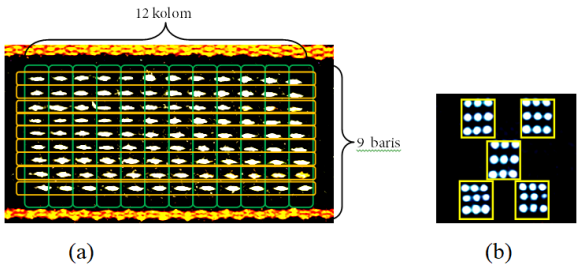


Figure 4: Multiplication representation 12x9 = 9x12, 3x3 dan 5x9

Figure 4 (a) is a multiplication representation 12x9 dan 9x12. The pattern of dots arranged in 12 column and 9 rows show multiplication 12x9= 9+9+9+9+9+9+9+9+9+9+9+9 atau 9x12 = 12+12+12+12+12+12+12+12+12. Figure 4 (b) shows a pattern of 9 dots arranged in groups of 5 groups. Each group is arranged in the form of a square matrix 3x3. Figur 4(b) represent 5x9 = 9+9+9+9+9 = 5 (3x3).

b. Number Pattern

Bajawanesse traditional weaving has certain patterns. In the context of school mathematics, several points on the *Keru* has form a certain mathematical pattern. One of them is the odd number pattern. If you look at the dots arranged like a triangle, you can identify odd number patterns 1, 3, 5, 7, 9 as following figure 5.

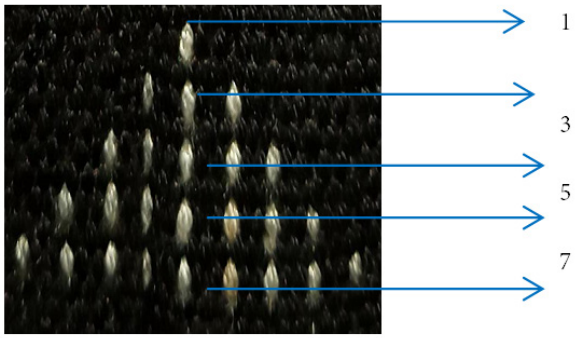


Figure 5: The Concept of Odd Number Patterns on *Keru*

Odd number patterns are important material that elementary school students must know and understand. It's the same as weaving activities in other areas in NTT, for example, woven fabrics from the Timor area (Tibo dalam Disnawati & Nahak, 2019) involving the abstraction process is making a woven pattern in the form of a pattern of even/odd numbers and multiples horizontally or longitudinally. H Setyawan *et al.*, (2018) developing student worksheets for junior high school number patterns based on Timor woven fabrics. They produce worksheets that have the potential to improve student learning outcomes. Learning number patterns can help students count faster related to objects being counted, so they can improve their mathematical pattern skills (Farida, 2014).

c. Geometry and Measurement

The subject of geometry is a combination of drawing concepts such as straight lines, perpendicular, bisector, and others are intertwined in an abstract logical statement. Therefore, the teacher's challenge in learning

geometry is the ability to facilitate students to introduce geometric terms and the ability to use this language to communicate geometric ideas. (Verner *et al*., 2019). Geometry learning aims to improve students' problem solving skills so it is recommended to follow the stages of van Hiele theory, namely visualization, analysis, informal deduction, formal deduction, and accuracy.

Primitive geometric elements are found in *keru* such as points, lines and planes. If you look at the two elongated sides of *keru*, there is an arrangement that resembles a ***g*** line and ***h*** line. The lines are two parallel lines.

Figure 6: Parallel Line Concept

Dotted motifs resembling intersecting lines are also found on the *keru*. Two or more lines are said to intersect if there is a common point crossed by the lines.

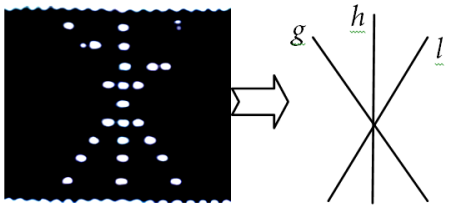
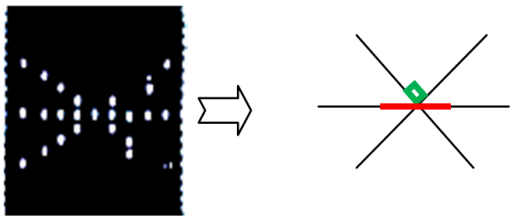


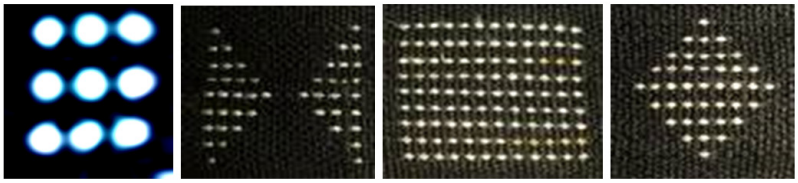
Figure 7: Lines intersect at "Keru"

The concept of angles is also found in Keru as shown in Figure 8. The types of angles, such as right angles, acute angles, obtuse angles and straight angles can be easily observed in all *Keru* motifs.



Figuree 8: The concept of angle on *Keru*

In addition to the primitive geometry above, the arrangement of the dots is the plane shapes identified on *Keru* such as squares, rectangles, triangles and rhombuses.



Gambar 9: Plane Figure on *Keru*

If you pay attention to the primitive geometry of the *keru*, it is Bajawa woven fabric, the same as the findings in ethnomathematical research on woven fabrics Sumba Nusa Tenggara Timur (Billy, Sujadi & Arigiyati, 2019; Ledi, Kusmanto & Agustito, 2020) and Sikka Fabric (Tobu, Murwati, & Putriantoro, 2020), Kui motif woven fabric of the Abui Alor tribe (Padafing, 2019).

The motif of dots resembling plane figure can help students at school to understand flat shapes arranged like on a plane figure. That is, the plane is filled with dots. Since the plane is filled with points, the number of points can represent a unit areas.

Therefore, the dotted motif on the "*keru*", can be used as a media for introducing the concept of flat area, such as the area of a triangle, the area of a rectangle, the area of a square and the area of a rhombus. The number of points in Figure 10 below is the product of the number of points on ***P*** times the number of points on ***L*.**

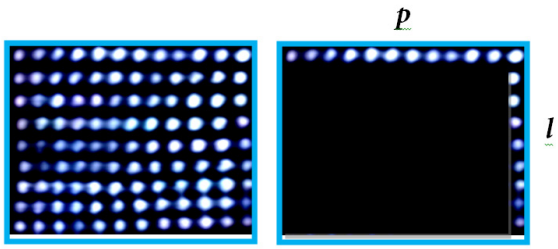


Figure 10 : The formula for the area of a rectangle A=pxl

Furthermore, a rhombus is an area formed by two congruent triangles (Figure 11). Thus the area of rhombus C is the sum of the area of A and the area of B.

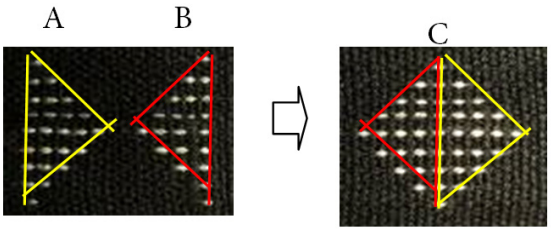


Figure 11: The concept of area of a rhombus

The introduction of the area of flat shapes is in elementary schools. The first is the area of a rectangle and a square, then the area of a triangle, and so on. It is the area of a rhombus. The formula for the area of a rhombus can use the formula for the area of a triangle as represented in Figure 11.

The woven fabric motif for calculating the area has been used in learning. The research is a design research by Haryani, Putri, & Santoso (2015) where activities are carried out starting from the use of checkered motifs in understanding measurements and sizes. The results of the learning experiment show that experience-based activities have helped improve students' understanding of area concepts.

In addition to learning the broad concept, the dotted motif (Figure 9) can be used as a media for learning the concept of circumference. The number of points at the outermost is the circumference of the plane figure.

d. Reflection

Transformation geometry is also used by weavers to compose a dotted motif on a *keru*. One of them is the concept of reflection or reflection. Several patterns on woven fabrics from other regions in Indonesia are also found in the *Keru* motif. The application of transformation geometry in the form of reflection is shown in Figure 12.

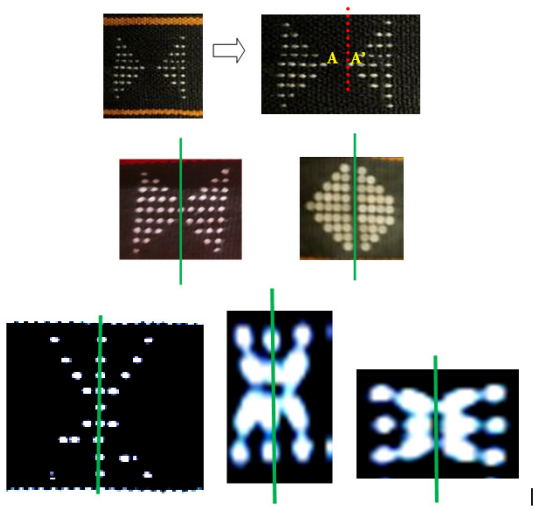


Figure 12: Concept of Reflection on Keru.

Applications of reflection or reflection on *Keru* are also found in regional woven motifs such as Riau weaving (Nurdin et all, 2019), Lampung cloth (Maskar & Anderha, 2019), Indramayu batik (Sudirman, Rosyadi, & Lestari, 2017) and other regional weave. In implementation, some researchers apply transformation geometry applications in mathematics learning such as Sudirman, Son & Rosyadi (2018), dan Tobu, Murwati, & Putriantoro (2020).

The main findings in this study are mathematical concepts including number patterns, multiplication as repeated addition, geometry and measurement and reflection. This mathematical concept is a concept given to elementary schools from low to high grade. This concept will be difficult for students to understand if it is presented with an abstract approach. We need a media that can be used to facilitate the understanding of abstract mathematical concepts into concrete. The implementation of sabuk tradisional Bajawa (*Keru*) media is one alternative. It can be used to make it easier to understand mathematical material and it is very suitable to be applied to provide an understanding of basic concepts. Students can construct their own informal knowledge of their culture by observing, counting or measuring each part of it. The teacher directs the informal knowledge towards formal or standard (Novrika *et al.,* 2016). Results can improve students' understanding of mathematics.

CONCLUSION

Elements of culture have a variety of mathematical content in elementary school. In addition to content, cultural elements can be used in mathematics pedagogy such as learning media.

In terms of various content or mathematics learning materials, sabuk tradisional Bajawa (*Keru*) contains geometry, including primitive geometric elements such as points, lines, angles; the concept of parallel lines, intersecting lines, the concepts of simple flat shapes, the concept of area and the concept of symmetry. In addition to geometric content, sabuk tradisional Bajawa also includes the concepts of multiplication, addition, and number patterns.

From mathematics pedagogy, Keru is a sabuk tradisional Bajawa that can be used as a media for learning mathematics in elementary schools. In addition, it can help teachers to understand and internalize concepts in ethnomathematics culturally, and inclusively.

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