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THE GEOMETRY TRANSFORMATION CONCEPTS IN BEAD CRAFT MOTIFS BY THE *KENYAH DAYAK* TRIBE

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Abstract: When studying mathematics, many students consider mathematics to be a difficult subject because they see it as a close system that prioritizes standards of rigor, speed, and memory. Conventional learning methods might make students bored. Various model is needed to overcome this. One of which is the culture associated with learning mathematics, known as ethnomathematics. The purpose of this study was to explore the bead crafts of the *Kenyah Dayak* tribe, located in Kalimantan, Indonesia, that develop heritage motifs attributed to the concept of geometric transformations on rotation and dilatation. This type of research was qualitative research involving observation, interviews, and documentation. The subject of this study was bead craft in the local area and the object of this study was the concept of geometric transformation on rotation and dilatation that exists in the craft motifs of the beads made. The data obtained in this study provides insights into the various cultural objects that can be used for triggering mathematics thinking. Through this resource, students may understand geometric concepts such as rotation and dilation, applicable to the real context of their daily life.

Keywords: bead craft, ethnomathematics, geometry transformation, rotation, dilatation

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INTRODUCTION

Education is one of the factors that play a role in fostering a person's progress, namely in the form of learning experiences that occur throughout life in the formation of the human person, where education has a role in shaping a good or bad personality. In this case, the government is very concerned about education issues because with a good education system, it is hoped that the next generation will be born capable and able to adjust to the life of society, nation, and state.

Many students who consider mathematics a problematic subject view it as a strict system that prioritizes standards of rigor (Novitasari, 2016). Students demonstrate their love for the local culture and their ability to use their culture to generate income while preserving their culture (Pingge, 2017).

The relationship between society and culture is one of the inseparable bonds in life, where society is an inseparable part of the development of its culture and heredity, which comes from daily activities and events derived from the culture of that community (Mahdayeni et al., 2019). Cultural objects might be integrated into mathematics learning. Each region has its own unique culture consisting of traditional houses that dominate the surroundings, traditional games, typical foods that are usually eaten every day, regional wedding customs, cloth motifs that are often used for certain occasions, regional handicrafts, and so on. One of the cultures that can be used as a source of ethnomathematics-based mathematics learning.

Heldanita (2018) defines by linking ethnomathematics to mathematics learning then by associating exploration as the process of seeing or observing something to find creative ideas. Exploration allows students to see, understand, feel, and ultimately create things that interest them. This activity is carried out by observing the environment in accordance with the existing reality directly. Such observations can be in the form of environments such as forests, hills, dunes, seas, ponds, and other natural environments.

Exploration allows the child to see, understand, feel, and ultimately create what interests them (Rachmawati & Kurniati, 2011). The term ethnomathematics refers to the application of mathematics by certain groups of people, such as urban and rural communities, indigenous peoples, working-class groups, children of certain social classes, and so on. Cultural anthropology (ethnography), mathematical modelling, and mathematical studies are themselves the core of studying ethnomathematics (Ulum, 2018).

This theory is comparable to Yuniar & Pujiastuti (2020) which argues that ethnomathematics defined as an anthropology of mathematical culture is a research that is very closely related to local culture in specific communities without their knowledge of mathematical concepts. For example, students learn geometry material, namely building space, the teacher shows objects that resemble or correspond to the building of the space such as paintings, tubes, fabrics, sculptures, and so on, where there is an arrangement of patterns and the beauty of nature and culture taught in mathematics. Juano & Jediut (2019) stating thatwith cultural interference, learning mathematics will be more helpful. Mathematics and culture are a kind of interrelationships that exist in all aspects of people's lives, wherever they are.

In order for students to understand mathematical concepts, including one of them the concept of geometric transformation, special methods are needed that correspond to their understanding. This was revealed by (Dahlan & Permatasari, 2018) when the teacher explained that in learning reflection and symmetry, the teacher uses works of art, namely examples of objects, tattoos, and other paintings that have local cultural motifs have a mirroring value after students are introduced to these forms, then introduce the concept of mirroring. This was stated by Widada et al. (2018) that math lessons are realistic or related to everyday life and can be used for mathematics learning.

Understanding, exploring, and engaging in cultural traditions can provide insight, increase creativity, and foster a sense of love for the homeland in relation to Indonesian culture. This is why it is essential to research education based on the culture of mathematics learning.

Research on ethnomathematics in East Kalimantan, Indonesia has been conducted. Hidayati & Sugeng (2021) applied a geometric transformation to Lia Maido's batik designs using Desmos. Edi (2021) has conducted a similar study on the traditional clothing of the *Kenyah Dayak* Tribe. It was known that in the traditional clothes of the *Kenyah Dayak* tribe, mathematical concepts were found such as geometric transformations in which there were translation, reflection, rotation, and dilatation.

This study aims to discover some of the relationships between mathematics learning that occurs in the *Kenyah Dayak* tribe. Besides clothes, bead crafts are also popular. The study was focused on the craft of beads on motifs of the *Dayak Kenyah* tribe, to understand what mathematical thinking can students learn from observing, using, or creating the bead motifs.

METHOD

This research was carried out in Pampang Village, where there was local production houses in Samarinda City, East Kalimantan Province, Indonesia. This research was conducated around the end of 2022. This study collected various bead motifs originating from *Dayak Kenyah*, in the Pampang village. This research uses an ethnographic approach where researchers tend to investigate the culture through talks with the local people and observation to their artefacts (Fitrah & Luthfiyah, 2018).

The purpose of the ethnographic approach is to study human behaviour in a particular natural environment and capture meaning based on the perspective of the research subject (emic and non-ethical approaches) (Suwendra, 2018). In this study, validation was carried out for the study's success consists of the mastery of material related to bead motifs and the various concepts of geometric transformations involved in making them. Additionally, unstructured interview questions and documentation on beads were administered. The researcher presents the data in narrative form by describing some of the existing mathematical aspects, then shows certain parts of the motif of bead crafts related to the concept of geometric transformation through rotation and dilatation.

RESULTS AND DISCUSSION

The research data was obtained through interviews with three bead crafters in the area. There was documentation of the bead craft, and there are five *Kenyah Dayak* motifs used in this research data, namely the *Pakis* motifs, *Asoq* motifs, *Bang Bekat* motifs, *Pun* motifs, and *Silung Kelunan* motifs which is contained in ten bean crafts. Each motif in each craft was identified which kind of the concept of geometric transformations applied. The data revealed that two concepts, rotation and dilatation, are involved.

Table 1. The Results of the Analysis of Rotational Linkages in Bead Craft Motifs

Bead Craft	*Pakis* Motif	R	*Asoq* Motif	R	*Bang Bekat* Motif	R	*Pun* Motif	R	*Silung Kelunan* Motif	R
Bening	✓	-	✓	✓	-	-	-	-	-	-
Saung Aban	✓	✓	-	-	-	-	-	-	-	-
Anjat	✓	✓	-	-	-	-	-	-	-	-
Besunung	✓	-	-	-	-	-	-	-	-	-
Batuk Sapei	✓	✓	-	-	-	-	-	-	-	-
Beluko Letto	-	-	✓	-	-	-	-	-	-	-
Sapei Inoq	✓	-	-	-	✓	✓	✓	-	✓	-
Avet	✓	✓	-	-	-	-	-	-	-	-
Ta'a	✓	✓	-	-	✓	✓	✓	-	-	-
Kelembit	✓	-	-	-	✓	✓	-	-	-	-

R= Rotation

Table 1 and Table 2 shows the concept of geometric transformations, rotation and dilatation, that can be attributed to the craft of beads through these motifs. By abstracting a form of the motif in the craft to find the concept of rotation and dilatation related to the existing bead craft motif.

Table 2. The Results of the Analysis of the Relationship of Dilatation on Bead Craft Motifs

Bead Craft	*Pakis* Motif	D	*Asoq* Motif	D	*Bang Bekat* Motif	D	*Pun* Motif	D	*Silung Kelunan* Motif	D
Bening	✓	-	✓	-	-	-	-	-	-	-
Saung Aban	✓	✓	-	-	-	-	-	-	-	-
Anjat	✓	-	-	-	-	-	-	-	-	-
Besunung	✓	✓	-	-	-	-	-	-	-	-
Batuk Sapei	✓	✓	-	-	-	-	-	-	-	-
Beluko Letto	-	-	✓	-	-	-	-	-	-	-
Sapei Inoq	✓	-	-	-	✓	-	✓	-	✓	-
Avet	✓	-	-	-	-	-	-	-	-	-
Ta'a	✓	-	-	-	✓	-	✓	-	-	-
Kelembit	✓	-	-	-	✓	-	-	-	-	-

D = Dilatation

Rotation

Rotation is the rotation of a body on a fixed axis. Rotation includes geometric transformations, which move points by means of rotating the points as far as θ with the center of a particular point. The following is a discussion related to the concept of geometric transformation through rotation related to existing bead craft motifs.

Bening

Figure 1 show how to see the concept of rotation in the *Asoq* motif using *Bening* bead craft.

Figure 1. Concept of rotation on *Bening*

Figure 2 is an abstraction of the rotation in the *Bening* bead craft. This figure can assist students to understand the transformation of the motifs.

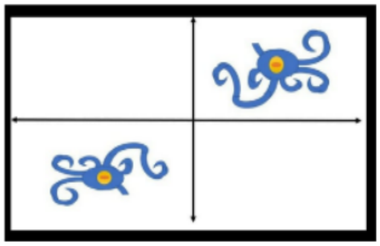

Figure 2. Illustration of the concept of rotation in *Bening*

By attributing the existing part of the clear and the two lines abstracted as cartesian coordinates, then the scheme of the concept of rotation of the center O with $\alpha = +180°$. Figure 3 show how *Asoq* motif using bening bead craft fits into the concept of rotation in this Cartesian coordinate plane. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the rotation concept. *Bening Dayak* is a traditional tool for carrying babies for the people of Pampang Village.

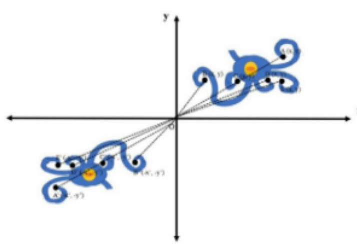

Figure 3. Scheme of rotation concept towards the center point O with clear $\alpha = +180°$ *Bening*

Saung Aban

Figure 4 show how to see the concept of rotation in the *Asoq* motif using *Saung Aban* bead craft.

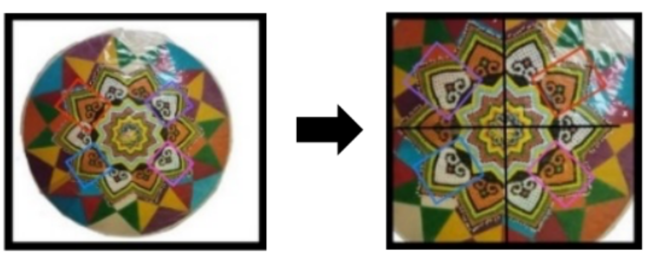

Figure 4. The concept of rotation in *Saung Aban*

Figure 5 is an abstraction of the rotation in the *Saung Aban* bead craft. This figure can assist students to understand the transformation of the motifs.

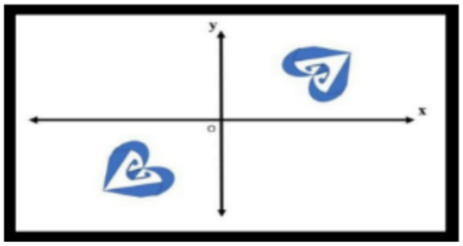

Figure 5. Illustration of the concept of rotation in *Saung Aban*

By attributing part of the existing *Saung Aban* and two lines abstracted as cartesian coordinates, then the scheme of the concept of rotation of the center O with $\alpha = +180°$. Figure 6 show how *Asoq* motif using *Saung Aban* bead craft fits into the concept of rotation in this Cartesian coordinate plane. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the rotation concept. *Saung Aban* is usually used as a hat by the people of Pampang Village to protect the sun.

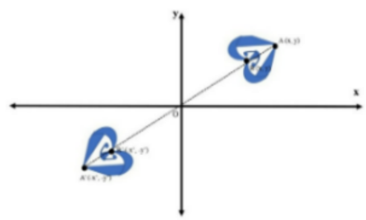

Figure 6. Scheme of rotation concept towards the center point O with on the $\alpha = +180°$ *Saung Aban*

Anjat

Figure 7 show how to see the concept of rotation in the *Asoq* motif using *Anjat* bead craft.

Figure 7. The concept of rotation on the *Anjat*

Figure 8 is an abstraction of the rotation in the *Anjat* bead craft. This figure can assist students to understand the transformation of the motifs.

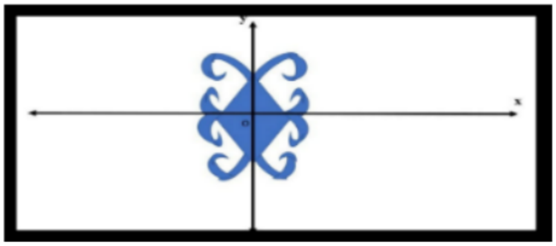

Figure 8. Illustration of the concept of rotation on the *Anjat*

By associating part of the existing *Anjat* and the two lines abstracted as cartesian coordinates, then the scheme of the concept of rotation of the center O with $\alpha = +180°$. Figure 9 show how *Asoq* motif using *Anjat* bead craft fits into the concept of rotation in this Cartesian coordinate plane. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the rotation concept. *Anjat* is commonly used as a bag by the people of Pampang Village.

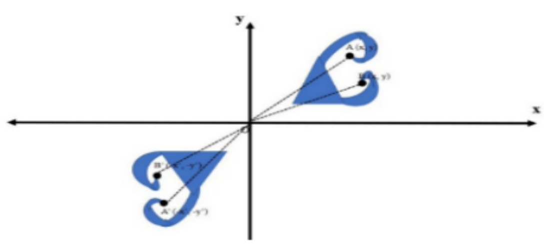

Figure 9. Scheme of rotation concept towards the center point O with on the $\alpha = +180°$ *Anjat*

Sapei Inoq

Figure 10 show how to see the concept of rotation in the *Asoq* motif using *Sapei Inoq* bead craft.

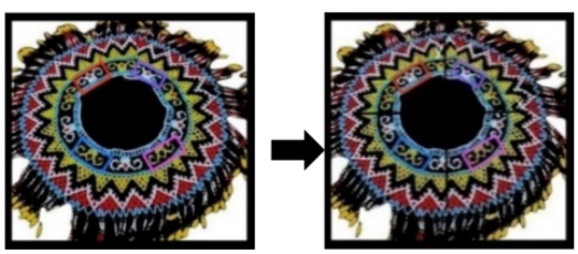

Figure 10. The concept of rotation in *Sapei Inoq*

Figure 11 is an abstraction of the rotation in the *Sapei Inoq* bead craft. This figure can assist students to understand the transformation of the motifs.

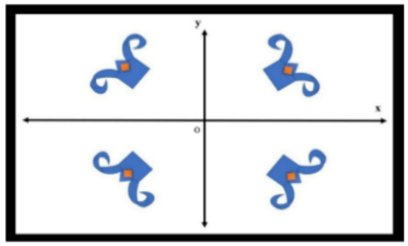

Figure 11. Illustration of the concept of rotation in *Sapei Inoq*

By attributing part of the existing *Anjat* and the two lines abstracted as cartesian coordinates, then the scheme of the concept of rotation of the center O with $\alpha = +180°$. Figure 12 show how *Asoq* motif using *Sapei Inoq* bead craft fits into the concept of rotation in this Cartesian coordinate plane. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the rotation concept. *Sapei Inoq* is a top dress for the *Dayak Kenyah* tribe.

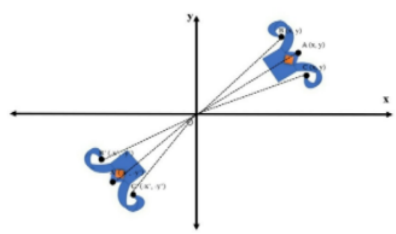

Figure 12. Scheme of rotation concept towards the center point O with in $\alpha = +180°$ *Sapei Inoq*

Avet

Figure 13 show how to see the concept of rotation in the *Asoq* motif using *Avet* bead craft.

Figure 13. The concept of rotation on *Avet*

Figure 14 is an abstraction of the rotation in the *Avet* bead craft. This figure can assist students to understand the transformation of the motifs.

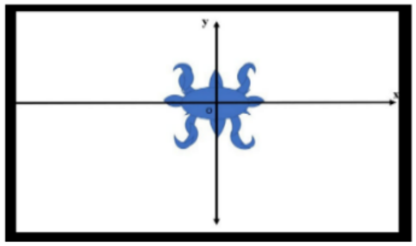

Figure 14. Illustration of the concept of rotation on *Avet*

By attributing part of the existing *Anjat* and the two lines abstracted as cartesian coordinates, then the scheme of the concept of rotation of the center O with $\alpha = +180°$. Figure 15 show how *Asoq* motif using *Avet* bead craft fits into the concept of rotation in this Cartesian coordinate plane. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the rotation concept.

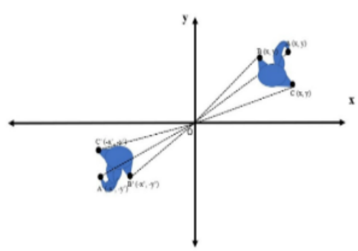

Figure 15. Scheme of rotation concept towards the center point O with on *Avet*
$\boldsymbol{\alpha = +180°}$

Ta'a

Figure 16 show how to see the concept of rotation in the *Asoq* motif using *Ta'a* bead craft.

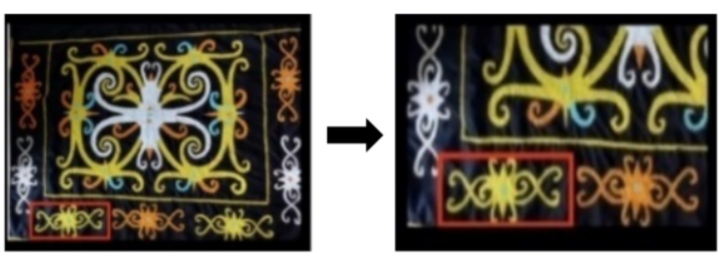

Figure 16. The concept of rotation in *Ta'a*

Figure 17 is an abstraction of the rotation in the *Ta'a* bead craft. This figure can assist students to understand the transformation of the motifs.

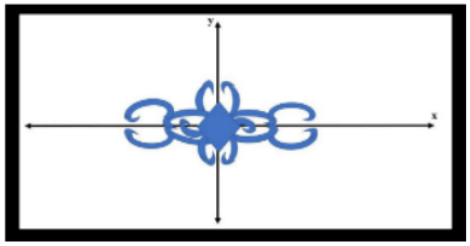

Figure 17. Illustration of the concept of rotation in *Ta'a*

By attributing part of the existing *Anjat* and the two lines abstracted as cartesian coordinates, then the scheme of the concept of rotation of the center O with $\alpha = +180°$. Figure 18 show how *Asoq* motif using *Ta'a* bead craft fits into the concept of rotation in this Cartesian coordinate plane. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the rotation concept. Ta'a is a tradinional dress of the *Dayak Kenyah* tribe.

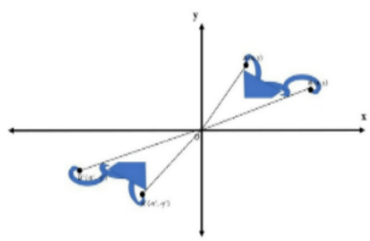

Figure 18. Scheme of rotation concept towards the center point O with on $\alpha = +180°$ *Ta'a*

Kelembit

Figure 19 show how to see the concept of rotation in the *Asoq* motif using *Kelembit* bead craft.

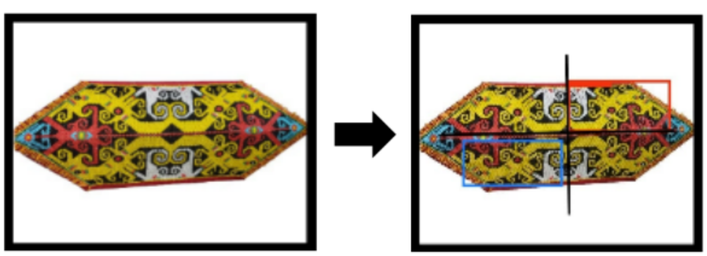

Figure 19. The concept of rotation in *Kelembit*

To clarify the concept of rotation in clear illustration of the concept of rotation in *Kelembit*. By attributing part of the existing *Kelembit* and the two lines abstracted as cartesian coordinates, then the scheme of the concept of rotation of the center O with $\alpha = +180°$. Figure 20 show how *Asoq* motif using *Kelembit* bead craft fits into the concept of rotation in this Cartesian coordinate plane. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the rotation concept. *Kelembit* is a shield for the *Dayak Kenyah* people to defend themselves from enemy attacks.

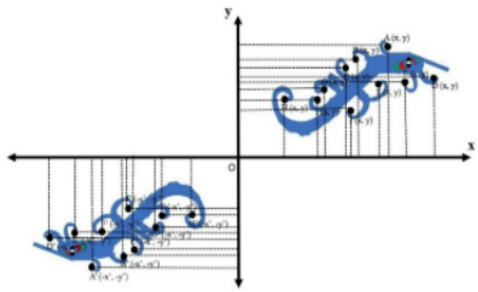

Figure 20. Scheme of rotation concept towards the center point O with on the $\alpha = +180°$ *Kelembit*

Dilatation

Dilatation is the multiplication of an object's size, defined as a transformation that changes the size (enlarges or decreases) of a geometric construct but does not change the shape of the geometric construct. The following is a discussion related to the concept of geometric transformation through dilatation related to existing bead craft motifs.

Saung Aban

Figure 21 show how to see the concept of dilatation in the *Asoq* motif using *Saung Aban* bead craft. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the dilatation concept.

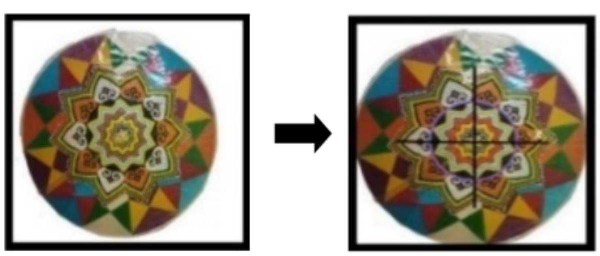

Figure 21. The concept of dilatation in *Saung Aban*

Besunung

Figure 22 show how to see the concept of dilatation in the *Asoq* motif using *Besunung* bead craft. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the dilatation concept.

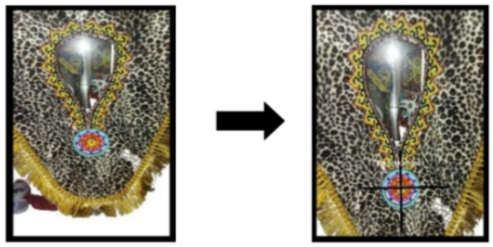

Figure 22. The concept of dilatation in *Besunung*

Sapei Inoq

Figure 23 show how to see the concept of dilatation in the *Asoq* motif using *Sapei Inoq* bead craft. In learning mathematics, this transformation concept exists in showing the real-life context of students, which contains the dilatation concept.

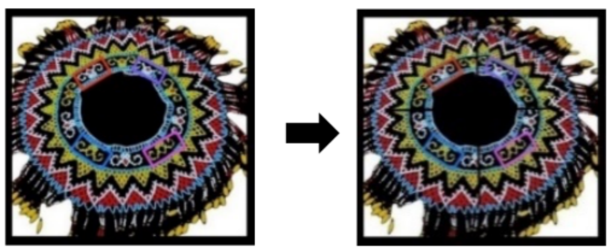

Figure 23. The concept of dilatation in *Sapei Inoq*

To make it easier to find this concept because it is difficult to find an appropriate point of view when taking data, the object to be searched for the concept of dilatation will be made an illustration or sketch (Figure 24).

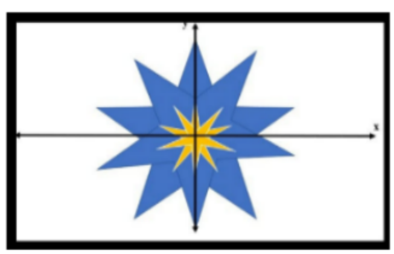

Figure 24. Illustration of the concept of dilatation in *Saung Aban*, *Besunung*, and *Sapei Inoq*

Figure 25 show how to facilitate the discovery of the concept of dilatation at the center O in *Saung Aban*, *Besunung*, and *Sapei Inoq*.

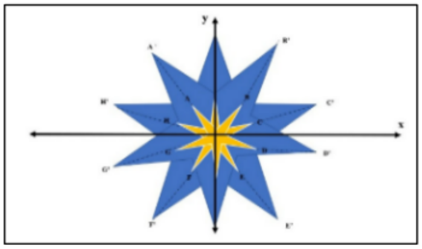

Figure 25. Scheme of the dilatation concept process with center O and scale factor k in *Saung Aban*, *Besunung*, and *Sapei Inoq*

Abstract mathematical concepts by associating objects with the use of environmental objects around students so that they become more concrete and meaningful. One approach that links mathematics with existing culture and is familiar to students is ethnomathematics. In particular, in ethnomathematics exploration, there is the concept of rotation and dilation of the beaded motif, which is a unique craft of the *Dayak Kenyah* tribe, Pampang Village. There are concepts of rotation and dilation that have been found in the beaded motifs, representing that culture and mathematics also apply and can be related so that the ability of mathematical connections when receiving geometric transformation material increases. This is in line with Huda (2018) which links mathematical concepts to objects in the Yogyakarta Special Region market snacks, Besurek Bengkulu cloth motifs (Yanti & Haji, 2019), *Dayak Kenyah* traditional clothing (Edi, 2021) and Banyuwangi traditional house (Hariastuti, 2018).

In learning mathematics, contextual learning approaches are intensively applied. In teaching mathematics, especially geometric transformations with motifs in beaded objects of traditional clothing, allow students can interpret the relationship between material and real life. In addition, this provides new insight for teachers that mathematical concepts taught at school can be integrated into a bead craft that is in the student's environment. This is in line with opinion from Lutvaidah (2015) that learning methods and approaches significantly influence students' mastery of mathematical concepts. Furthermore, contextual learning makes students more active in learning compared to conventional learning because the simulated problems match real life (Kadir, 2013). Through contextual learning, students can gain an understanding that can be applied to the real context of their daily lives.

We hope to see many uses of cultural objects such as beads with motifs representing mathematical concepts, especially geometric transformations. It is necessary to further explore surrounding objects that can represent the concept of geometric transformations in particular and generally other mathematical concepts to become more concrete.

Surrounding objects that are diverse and show the characteristics of each regional culture need to be exposed in ethnomathematics. With ethnomathematics, the abstract concept of transformation becomes easier to teach and understand to students. This aligns with the results of research conducted by Hardiarti (2017), Sukmawati et al. (2022), Kristanti et al. (2022), and Wahyuni & Alifia (2022) that learning mathematics through ethnomathematics objects can make mathematics more applicable and concrete. In his study, Hardiarti (2017) presented the concept of geometric shapes in the flat rectangular shapes found in the Muaro Jambi temple. Sukmawati et al. (2022) presented several mathematical concepts and geometric materials at the Jami' Al-Falah Mosque in Jember. Kristanti et al. (2022) examined ethnomathematics in the *methik pari* tradition, like designing designs containing geometric shapes such as squares, rectangles, circles, and cones. Wahyuni & Alifia (2022) identified mathematical elements, namely the geometry of the flat shapes and the geometric shapes and sequence patterns found in the Probolinggo Museum.

Ethnomathematics can link local wisdom culture to learning materials with the concept of school mathematics material. This is similar to what Silvia (2021) has done, that *Dayak*-style beads are teaching materials in preparing learning material. Therefore, contextual learning that places more emphasis on exploring cultural objects that can represent mathematical materials, especially geometric transformations, still has the potential to be developed and studied further so that it contributes to adding to the treasures of mathematics with local wisdom or the culture in which the student's environment is located.

CONCLUSION

When studying mathematics, many students consider mathematics to be a difficult subject because they see it as a close system that prioritizes standards of rigor, speed, and memory. There are various ways to employ ethnomathematics for understanding how . The purpose of this study was to explore the bead crafts of the *Kenyah Dayak* tribe through the motifs found and attributed to the concept of geometric transformations on rotation and dilatation. Crafts motifs had associated with mathematical objects related to geometric transformations, namely through rotations and related dilatation to bead crafts. Working on the motifs could develop mathematical creativity.

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