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Geometry Concept in Banyuwangi Traditional Dance Music

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Abstract. Music is a part of everyday life for every human being. Traditional music, especially music that accompanies traditional dances, is a part of a culture that has lost its closeness to student life. Whereas traditional music contains many interesting concepts of knowledge to be used as the basis for learning. *Gandrung Jejer Jaran Dawuk* (GJJJ) dance is one of the traditional dances from Indonesia which contains various concepts of knowledge. The accompanying music also contains many concepts of knowledge, particularly geometry. Geometry is one of the concepts in mathematics that is difficult for students to understand at elementary, secondary, and higher levels without visual objects. Geometric concepts can be explored from the musical accompaniment of the GJJJ dance, such as two-dimensional shapes (rectangles, trapezoids, circles, semicircles, and triangles), three-dimensional shapes (prisms, beheaded prisms, and beheaded cones), parallel and intersecting lines, similarity, and fractal geometry. The exploration of the musical accompaniment of the GJJJ dance shows that musical instruments and their notations can become interesting visual objects in learning mathematics, especially in the concept of geometry. Geometric concepts that have been explored still require further processing to be part of learning in schools in various forms such as teaching materials or learning media.

Keywords : Banyuwangi culture, traditional dance music, *Gandrung Jejer Jaran Dawuk* (GJJJ) dance, geometry concept.

INTRODUCTION

Banyuwangi is one of the districts in Indonesia that has a variety of cultural traditions, one of which is a traditional dance. *Gandrung* is a dance that characterizes Banyuwangi. *Gandrung* dance has several developments such as the *Jejer Gandrung* dance, the *Gandrung Jejer Jaran Dawuk* dance, and others. This research is focused on the *Gandrung Jejer Jaran Dawuk* (GJJJ) dance, especially the music that accompanies the dance. GJJJ is one of the *Gandrung* dance developments carried out by Sumitro Hadi which depicts the movement of the *dawuk* horse with an active character [1].

In general, every dance cannot be separated from the musical accompaniment that makes the dance more interesting. Music is an arrangement of sounds with certain rules that contain rhythm, song, tune, and harmony. The sound can be produced from various forms of tools or objects that can make a sound. The GJJJ dance is accompanied by several sounds of musical instruments, such as : two violins, two *kendangs*, two *ketuks*, two *gongs* (large and small), a *kluncing*, and a *Banyuwangen gamelan* consisting: four *sarons*, two *pekings*, two *angklung*, and two *selentem* [2]. Figure 1 is a traditional music performance that accompanies the GJJJ dance.



FIGURE 1. GJJJ Dance Accompaniment Music

Each musical instrument used to accompany the GJJJ dance has different and unique characteristics. However, in general, it contains geometric concepts such as shapes, surface area, and volume. Such as *kendangs*, *ketuks*, and *gongs* which have a circular surface, *kluncing* which has a triangular shape, *peking*, *selentem*, and *saron* which have rectangular blades.

Geometry is a part of mathematics that discusses shape, size, position, and the properties of various shapes. Geometry has a very significant position in education because most of the objects used in everyday life are geometric objects [3]. Geometry teaches how to give appreciation to something, how to find connections that occur between geometry material and other learning materials, and practice communication through exploration, discussion, conjecture, and investigation activities [4].

Many students have difficulty learning geometry [5]. Problems in learning geometry include proof, perception, misconceptions of visual processes and activities, and the use of procedures, concepts, and principles [4]. This makes geometry often disliked by most students, causing misunderstanding, and its notations are usually ignored [6]. This condition requires thinking so that concepts in geometry can be conveyed to students while making learning geometry fun and easy for students to understand.

Learning mathematics, especially studying geometry, through music can be an interesting thing. The use of music in mathematics learning takes a fairly slow and tentative time, although there is evidence that music and mathematics are related in science [7]. Music is an ideal art form to integrate into mathematics learning because the relationship between music and mathematics is very diverse which includes melody, rhythm, intervals, scales, harmony, tuning, and temperament [8].

Previous research has shown that there are advantages for teachers who use music-themed activities as a context for learning mathematics in a challenging but fun learning environment [9]. In other studies it has been shown that music can be used : (1) to engage students in fun mathematics learning in a relevant way; (2) as a resource by the teacher to present and design math problems in an irregular way. So that students have the opportunity to apply mathematical knowledge in a meaningful way and connect new mathematical knowledge with existing prior knowledge [8]. For this reason, it is important to explore music, especially traditional music, which is part of the culture that is understood by students. As well as designing the implementation of mathematics learning (especially geometry) that involves traditional music in it.

MATERIALS AND METHOD

This research was conducted qualitatively with an exploratory method assisted by literature review, from July 2020 to March 2021. There were 3 research informants, including (1) GJJJ dance composer; (2) music coach, violin maker, as well as GJJJ dance accompaniment music player (*panjak*); dan (3) GJJJ dance accompaniment music player (*panjak*). The objects of this research are musical instruments and musical compositions for the GJJJ dance accompaniment.

Data were collected using in-depth interviews, participatory observation, and cultural documentation. Participatory observations were made during rehearsals and GJJJ dance performances. In-depth interviews were conducted with 3 informants using interview guidelines. Cultural documentation was collected in the form of photos, videos, and interview transcripts. The data that has been collected is then analyzed together with the process of collecting data and writing research findings according to the steps in the ethnographic method [10] [11].

RESULTS AND DISCUSSION

Exploration of Gandrung Jejer Jaran Dawuk Dance Accompaniment

This research was conducted during the covid pandemic period which gave many obstacles because GJJJ dance performances were rarely done. So that data collection is mostly done in dance studios and traditional schools which also train the use of traditional musical instruments. The first informant was Sumitro Hadi, who composed the GJJJ dance and composed the accompanying music. The explanation of the musical instruments used to accompany the GJJJ dance is as stated in the GJJJ dance description [2].

The musical instruments used as an accompaniment to the GJJJ dance are two violins, two *kendangs*, two *ketuks*, two *gongs* (large and small), a *kluncing*, and a set of *Banyuwangen gamelan* consisting of two *saron*, two *peking*, two *angklung*, and two *selentem*. The musical instrument that accompanies the GJJJ dance can be seen in figure 2.



FIGURE 2. GJJJ Dance Accompaniment Music

Sumitro Hadi also explained the GJJJ dance accompaniment notation. The *Banyuwangen* tone (Banyuwangi music) has only the following notes : do (*ji*, the name for *siji* or one), re (*ro*, penyebutan untuthe name for *loro* or two), mi (*lu*, the name for *telu* or three), sol (*mo*, the name for *limo* or five), la (*nem*, the name for *enem* or six). These notes are called *selendro Banyuwangen*. The musical notation that accompanies the GJJJ dance according to the first informant is as in Figure 3 below.

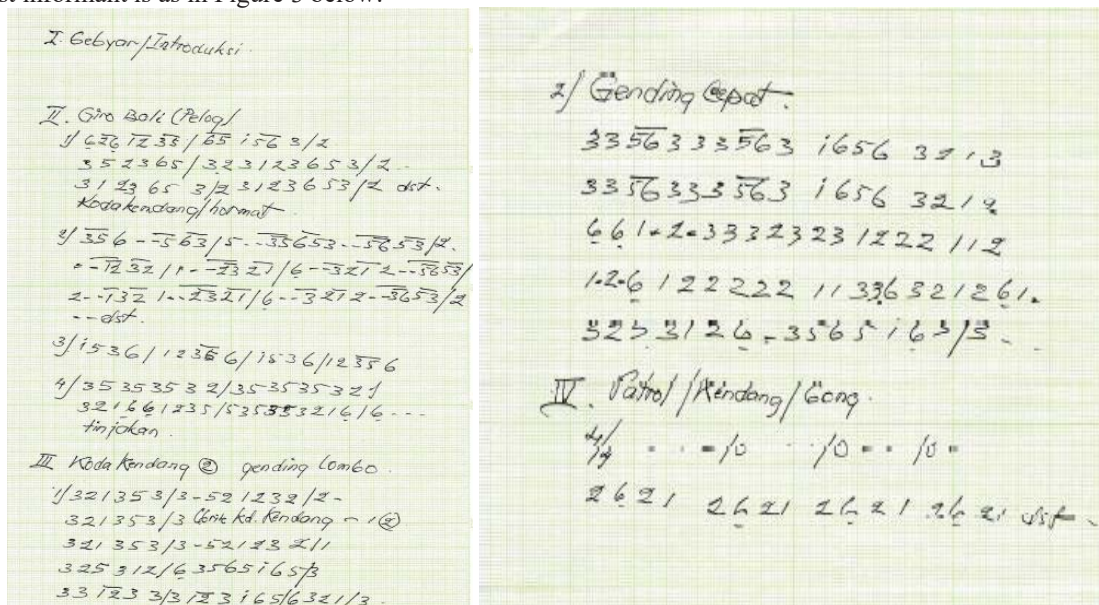


FIGURE 3. Music Accompaniment of GJJJ Dance According to the First Informant

The musical notation is only written in general because the first informant did not understand musical notation. He composed the accompanying music by humming his music, which was understood and embodied by the *panjak* who were accustomed to playing traditional Banyuwangi music. Meanwhile, the second informant, who is a musical

instrument maker, trainer, as well as a music player (*panjak*), can write down the musical notation for the GJJD dance accompaniment as shown in Figure 4 below.

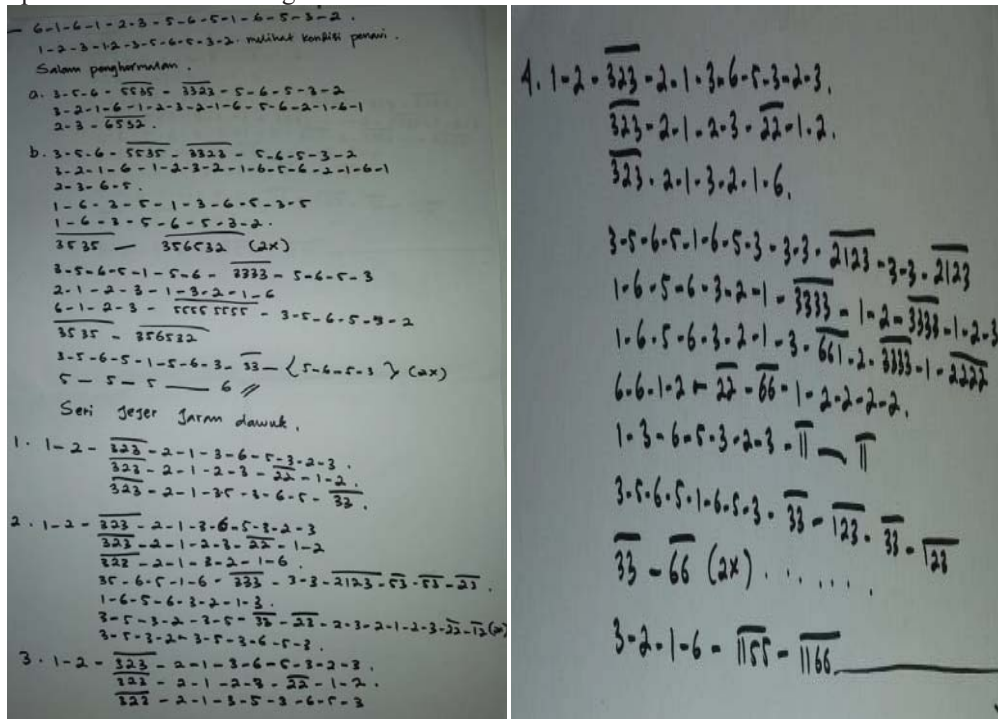


FIGURE 4. Music Accompaniment of GJJD Dance According to the Second Informant

The notation in Figure 3 and Figure 4 is commonly used as a guide in the *Banyuwangen gamelan* which has a *selendro* tone. As for other musical instruments, it adapts to the *gamelan* playing. The musical notation in Figure 4 can be described as a diagram as follows in figure 5.

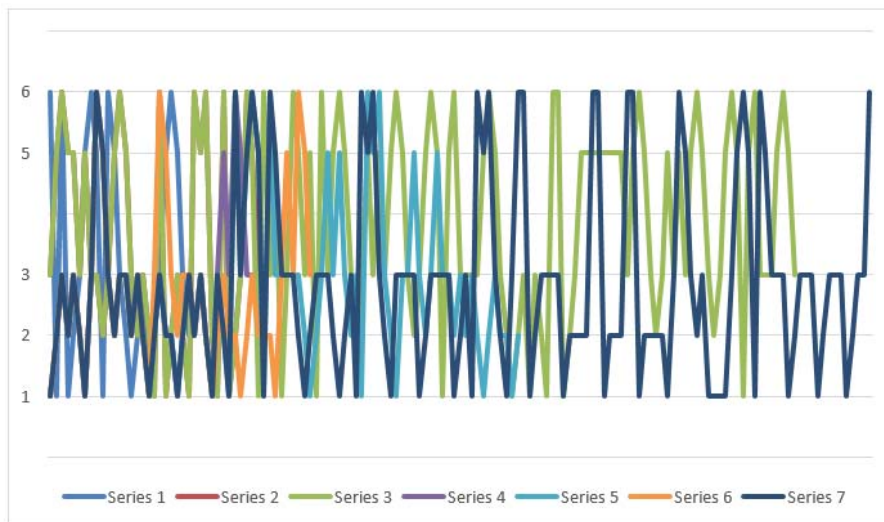


FIGURE 5. Overview of GJJD Dance Accompaniment Notation in Graphic Form

The depiction of the GJJD dance accompaniment music notation in figure 5 shows the principle of symmetry and self-similarity which is a feature of fractal geometry. However, determining the fractal dimension is considered quite difficult to do. This is because identifying fractals in music requires a different approach compared to looking at an image where the structure can be seen immediately [12]. A study of fractal-based curves in musical creativity suggests that fractal dimensions in music may not exist as non-integer [13]. This contrasts with other studies which

state that the fractal dimensions of traditional music are $N = 18$, which is almost the same as electronic music with fractal dimensions $N = 19$ and concert music with fractal dimensions $N = 16$ [14].

The Banyuwangi *gamelan* consists of *selentem/panthus*, *saron*, *peking*, and *angklung* as shown in figure 6. *Selentem*, *saron*, and *peking* are musical instruments consisting of blades made of iron and mounted on wooden frames.

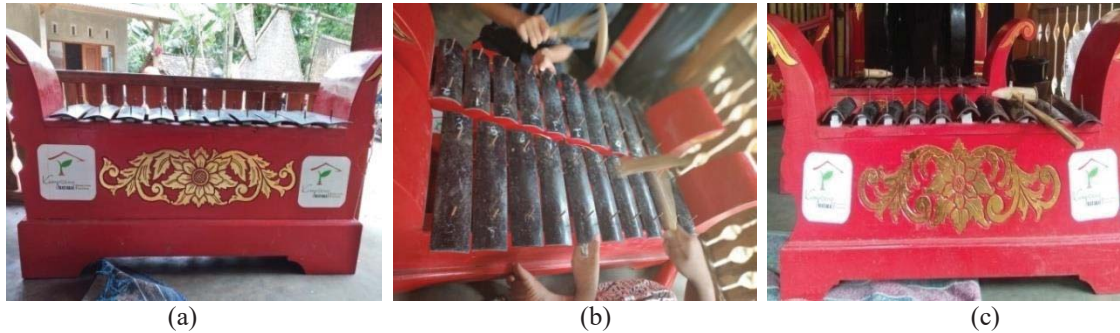


FIGURE 6. (a) *Selentem*, (b) *Saron*, (c) *Peking*

Figure 7 (a) shows that each *selentem*, *saron*, and *peking* have ten blades in the order of notation. The length of each iron blade varies depending on the *gamelan* maker. The first three bars represent the lower notes (*lu*, *mo*, *nem*), followed by five for the normal notes (*ji*, *ro*, *lu*, *mo*, *nem*), and two for the high notes (*ji*, *ro*). *Selentem*, *saron*, and *peking* are played by beating them using a wooden club with a shape resembling a tube (as shown in Figure 7 (a)).

The wooden frame supporting the *gamelan* is made a hole in the middle (Figure 7 (b)) so that when the *gamelan* is struck it does not cause an echo, but the sound produced is still loud. *Selentem* has the most horizontal blade shape, *saron* has a more curved blade shape when compared to *selentem*. While *peking* has the most curved blades resembling a semicircle. The curvature of the *gamelan* blades influences the sound of the *gamelan*. So the sound of *saron* is a normal voice, while *selentem* has a low voice and *peking* has a high voice. This means that the more curved the iron blade, the higher the sound produced.



FIGURE 7. The Sequence of Notation on Ten Blades of Banyuwangi *Gamelan*.

When viewed from above (as in Figure 7 (a)), each blade of *selentem*, *saron*, and *peking* resembles a rectangular shape. The arrangement of the iron blades is positioned parallel as well as lines that do not intersect or cross. The length of each blade has a certain size that is adjusted so as not to change the pitch and resonance of the sound. This is by previous studies which showed that the longer the blades in a *gamelan* would lead to lower tones and longer resonances, and vice versa [15]. Meanwhile, if you look at it from the side (as in Figure 6), each blade shows a difference in level, as discussed in the previous paragraph. The support for each *gamelan* shows the shape of a space resembling a beheaded prism.

Angklung is a musical instrument with a blade made of bamboo and a frame made of wood. The main key in playing *angklung* is memorizing and understanding the song to be played. As a companion in the GJJJ dance, it takes two *angklung* that are played together and mutually, called *kelencangan*. The tone of banyuwangi *angklung* is the same as *selentem*, *saron*, and *peking*, such as do (*ji*), re (*ro*), mi (*lu*), sol (*mo*), la (*nem*). As a result, the banyuwangi *angklung* can only be used to accompany Banyuwangi songs.



FIGURE 8. Banyuwangi Angklung

Angklung in Banyuwangi, as seen in figure 8, has fifteen bamboo blades, each of which resembles a tube shape. The fifteen blades consist of five low rhythm blades (*lu, mo, nem, ji, ro*), five normal rhythm blades (*lu, mo, nem, ji, ro*), and five high rhythm blades (*lu, mo, nem, ji, ro*). Each blade will make a sound when struck with two bats made of wood in the shape of a small tube.

The length of each bamboo blade on the angklung differs depending on the angklung maker. This means that there is no mandatory basis for determining the length of bamboo blades. But the length of the bamboo blade is getting shorter from left to right. So the shorter the bamboo blade, the higher the sound. Angklung makers generally carry out the process of equating the diameter and length of the bamboo that will be used as an angklung blade with the size of the finished bamboo using traditional unit concepts such as *sak kilan*, *sak nyengking*, and finger diameter [16].

The arrangement of the bamboo blades is positioned like a parallel line. The angklung supports have a trapezoidal shape, each angklung blade has a circular surface, while the angklung blades and the bat have a tube shape. This is by previous studies which showed the trapezoid concept on the angklung support, the circle concept on the angklung blade, and the tube concept on the angklung blade and the beater [16].

The violin is a musical instrument that must exist in Banyuwangi traditional music performances. In the music for GJJJ dance, the violin is used with a tone that matches the *gamelan* playing. The violin has four basic notes, namely G, D, A, E, which are the same as the basic notes of the violin in general. The difference between the Banyuwangi violin and the one commonly used is that the four tones are lowered (the strings are set at a low pitch) to match the tone played by the *gamelan* and the song being sung. In addition, the Banyuwangi violin string pattern is performed on two strings at once, giving rise to a double tone sound.



(a) (b)
FIGURE 9. Violin : (a) Front look, (b) Back view

The violin is a stringed instrument that has a shape resembling a prism. The top and base surfaces of a prism are plane shapes with regular curved sides, as we can see in figure 9 (a) and (b). The four strings representing the notes G, D, A, and E resemble four lines that meet a point at the end of the violin. The string key is located at the end of the violin with a symmetrical position to the right and left (two each).

Kendang is a percussion instrument that has a role in the GJJJ dance. At some intervals of dance movements, there is a *koda kendang*, meaning that there is a *kendang* game that becomes the code for the dancer to make the next movement. They are two sizes of *kendang*, namely large (*kendang wadon/female*) and small (*kendang lanang/male*). Both types of *kendang*s are shown in figure 10. *Kendang wadon* is used as a compliment, while *kendang lanang* is the main *kendang* in the GJJJ accompaniment music. The size of *kendang lanang* and *kendang wadon* depends on the maker (no mandatory size). Each *kendang* has two circular surfaces (large and small). The

two surfaces have different sizes. So that the shape of *kendang* is more like a beheaded cone, not a tube. This is by previous research which mentions the concept of a circle and a beheaded cone on *kendang* [15] [17].



FIGURE 10. *Kendang Lanang* (left) and *Kendang Wadon* (right)

Playing *kendang* must pay attention to playing other musical instruments because *kendang* is complementary to certain parts in accompanying the GJJJ dance. Playing *kendang* on the GJJJ dance accompaniment is done with a hard blow. The strokes on *kendang lanang* are carried out on both surfaces, while the punches on *kendang wadon* are carried out only on the large surface. There are five ways to hit *kendang lanang* as shown in Figure 11.

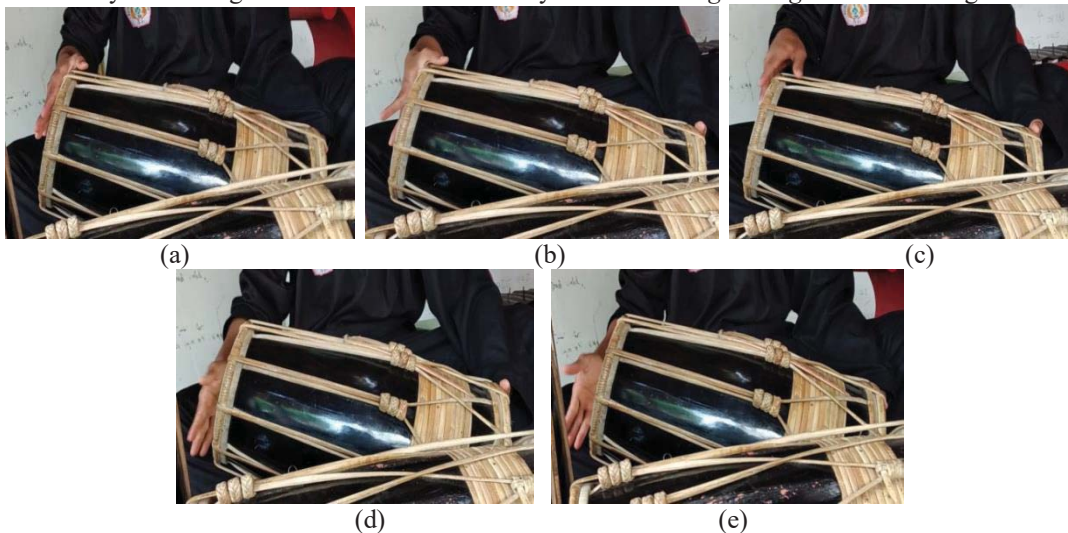


FIGURE 11. Five Ways to Hit *Kendang*

The strokes on *kendang* do not follow the notation used in the *gamelan*. The *kendang* player must have the skill to hit *kendang* to match the tone produced by other musical instruments.

Not only *kendang*, but *kluncing* is also a distinctive musical instrument that should not be abandoned. *Kluncing*, as shown in figure 12, is a percussion instrument made of iron which is shaped like a triangle. More specifically, in previous studies, it was mentioned that *kluncing* has a shape resembling an isosceles triangle [15]. The bat is also an iron that resembles a tube.



FIGURE 12. *Kluncing*

Kluncing is played by hitting a long iron (batter) against a triangular iron in harmony with the rhythm produced by the *gamelan Panjak* (player) *kluncing* is in charge of giving directions to GJJJ dancers during the intermission of the accompaniment music, which is called *kudangan kluncing*.

Gong is a percussion instrument made of iron. There two *gongs* used, namely *gong kung* (small) and *gong gol* (large). The *gong* is played without notation but adapts to *gamelan* and violin. The *gong* is hit with a bat made of wood wrapped in cloth (as shown in Figure 13 (b)).

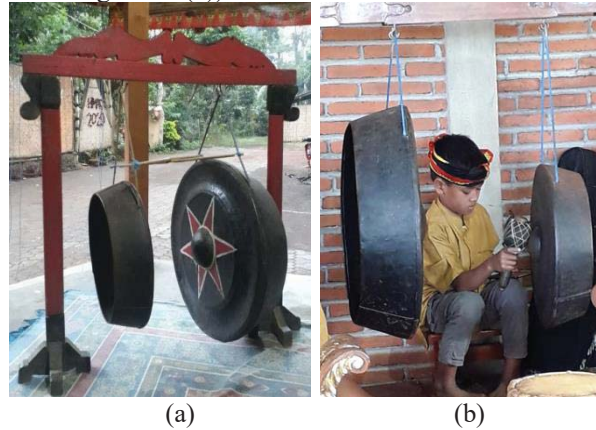


FIGURE 13. *Gong*

Gong has a surface resembling a circle. While the overall shape of the *gong* is a hollow shape resembling a beheaded cone. This is by previous research which mentions the concept of a beheaded cone on the *gong* [15]. The two *gongs* are not the same size, so they appear to be similar with a certain size ratio.

The last musical instrument used is *ketuk*. *Ketuk* is similar in shape to the *gong* but in a much smaller size. So that *ketuk* also has a surface shape resembling a circle and as a whole is a hollow space shaped like a beheaded cone, as we can see in figure 14. This is following the results of previous studies which showed the concept of a circle on a percussion-like *ketuk* [18] and a beheaded cone [15].



FIGURE 14. *Ketuk*

Ketuk is not hung like a *gong*, but is placed on the floor and played by hitting it. Beaters are usually made of wood or bamboo. There are two *ketuks* needed in the GJJJ dance accompaniment with different sizes. The difference appears as a similarity shape with a certain size ratio.

Geometry Learning Based on *Gandrung Jejer Jaran Dawuk* Dance Accompaniment Music

The results of the exploration of GJJJ's dance accompaniment music show that there are various geometric concepts both in musical instruments and in musical notation. These concepts include two-dimensional figures (rectangles, trapezoids, circles, semi-circles, and triangles), three-dimensional figures (prisms, beheaded prisms, and beheaded cones), parallel lines, similarity, and fractal geometry. These concepts can be the basis for learning geometry in primary, secondary, and higher education.

The basics of geometry are part of teaching visualization to students in basic education. Visualization is the lowest level in geometric thinking, that begins with a nonverbal process through identifying, comparing, and operating geometric shapes such as triangles, angles, or intersections, according to their appearance [19]. Students

with less visual competence will face problems in solving geometry problems in particular, as well as mathematics in general [20].

To be able to identify the shape, position, and condition can be done with musical instruments to accompany the GJJJ dance. For example, rectangular and trapezoidal shapes on *gamelan* (figure 15), circles on *gongs*, *ketuk*, and *kendang* (figure 16), triangles on *kluncing*, parallel lines positions on *gamelan* and *angklung* (figure 17), intersecting lines on violin strings (figure 18), the similarity of circles on the surface of *gongs*, *ketuks*, and *kendangs*, and so on.



FIGURE 15. (a) Trapezoid Visualization and (b) Rectangle Visualization



FIGURE 16. Circle Visualization and Circle Similarity



FIGURE 17. Parallel Line Visualization



FIGURE 18. Intersecting Line Visualization

This visualization ability will make it easier for students to carry out geometric thinking processes at the next levels. An understanding of geometry starting from basic education is important because of its influence not only in the mathematics learning process but also in other subjects, as well as in daily life needs. This makes geometry an important component in the primary and secondary school curriculum, even becoming one of the most complex parts of the curriculum [20].

As for the visualization and theory in fractal geometry, it is easier to understand at the higher education level. One of the reasons is because fractal geometry helps explain things and situations that cannot be explained in

Euclidean geometry [21], while students in primary and secondary education are still in the process of understanding Euclid's geometric concepts. For this reason, the concept of fractal geometry in GJJJ dance music can be given in higher education.

This discussion shows that music can be a basis for designing geometry lessons at various levels of education. The unique features that exist in music can be a resource for students to make connections in learning, as well as a way to represent mathematics in different alternatives [9]. But all of that still requires more ability from the teacher to be able to integrate music in learning geometry.

CONCLUSION

Geometry as part of mathematics is one of the concepts that require more understanding from the beginning (visualization) so that further thinking processes can be more easily carried out. Geometry is contained in the music, especially the music for the *Gandrung Jejer Jaran Dawuk* (GJJJ) dance. These concepts include two-dimensional shapes (rectangles, trapezoids, circles, semicircles, and triangles), three-dimensional shapes (prisms, beheaded prisms, and beheaded cones), parallel and intersecting lines, similarity, and fractal geometry. In this study, these concepts can be developed into the basis of visual geometry learning. The next research can be done to develop geometry learning based on GJJJ dance music in the form of analysis and problem-solving.

ACKNOWLEDGMENTS

Profound thanks and appreciation are given to Banyuwangi artists, especially to the late Mr. Sumitro Hadi who passed away on December 26, 2020. Hopefully, Banyuwangi culture can continue to be explored and integrated into learning at every level of education.

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
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Keywords : Banyuwangi culture, traditional dance music, *Gandrung Jejer Jaran Dawuk* (GJJD) dance, geometry concept.

INTRODUCTION

Banyuwangi is one of the districts in Indonesia that has a variety of cultural traditions, one of which is a traditional dance. *Gandrung* is a dance that characterizes Banyuwangi. *Gandrung* dance has several developments such as the *Jejer Gandrung* dance, the *Gandrung Jejer Jaran Dawuk* dance, and others. This research is focused on the *Gandrung Jejer Jaran Dawuk* (GJJD) dance, especially the music that accompanies the dance. GJJD is one of the *Gandrung* dance developments carried out by Sumitro Hadi which depicts the movement of the *dawuk* horse with an active character [1].

In general, every dance cannot be separated from the musical accompaniment that makes the dance more interesting. Music is an arrangement of sounds with certain rules that contain rhythm, song, tune, and harmony. The sound can be produced from various forms of tools or objects that can make a sound. The GJJD dance is accompanied by several sounds of musical instruments, such as: two violins, two *kendangs*, two *ketuks*, two *gongs* (large and small), a *kluncing*, and a *Banyuwangen gamelan* consisting of: four *sarons*, two *pekings*, two *angklung*, and two *selentem* [2]. Figure 1 is a traditional music performance that accompanies the GJJD dance.



FIGURE 1. GJJJ Dance Accompaniment Music

Each musical instrument used to accompany the GJJJ dance has different and unique characteristics. However, in general, it contains geometric concepts such as shapes, surface area, and volume. Such as *kendangs*, *ketuks*, and *gongs* which have a circular surface, *kluncing* which has a triangular shape, *peking*, *selentem*, and *saron* which have rectangular blades.

Geometry is a part of mathematics that discusses shape, size, position, and the properties of various shapes. Geometry has a very significant position in education because most of the objects used in everyday life are geometric objects [3]. Geometry teaches how to give appreciation to something, how to find connections that occur between geometry material and other learning materials, and practice communication through exploration, discussion, conjecture, and investigation activities [4].

Many students have difficulty learning geometry [5]. Problems in learning geometry include proof, perception, misconceptions of visual processes and activities, and the use of procedures, concepts, and principles [4]. This makes geometry often disliked by most students, causing misunderstanding, and its notations are usually ignored [6]. This condition requires thinking so that concepts in geometry can be conveyed to students while making learning geometry fun and easy for students to understand.

Learning mathematics, especially studying geometry, through music can be an interesting thing. The use of music in mathematics learning takes a fairly slow and tentative time, although there is evidence that music and mathematics are related in science [7]. Music is an ideal art form to integrate into mathematics learning because the relationship between music and mathematics is very diverse which includes melody, rhythm, intervals, scales, harmony, tuning, and temperament [8].

Previous research has shown that there are advantages for teachers who use music-themed activities as a context for learning mathematics in a challenging but fun learning environment [9]. In other studies it has been shown that music can be used: (1) to engage students in fun mathematics learning in a relevant way; (2) as a resource by the teacher to present and design math problems in an irregular way. So that students have the opportunity to apply mathematical knowledge in a meaningful way and connect new mathematical knowledge with existing prior knowledge [8]. For this reason, it is important to explore music, especially traditional music, which is part of the culture that is understood by students. As well as designing the implementation of mathematics learning (especially geometry) that involves traditional music in it.

MATERIALS AND METHOD

This research was conducted qualitatively with an exploratory method assisted by literature review, from July 2020 to March 2021. There were 3 research informants, including (1) GJJJ dance composer; (2) music coach, violin maker, as well as GJJJ dance accompaniment music player (*panjak*); dan (3) GJJJ dance accompaniment music player (*panjak*). The objects of this research are musical instruments and musical compositions for the GJJJ dance accompaniment.

Data were collected using in-depth interviews, participatory observation, and cultural documentation. Participatory observations were made during rehearsals and GJJJ dance performances. In-depth interviews were conducted with 3 informants using interview guidelines. Cultural documentation was collected in the form of photos, videos, and interview transcripts. The data that has been collected is then analyzed together with the process of collecting data and writing research findings according to the steps in the ethnographic method [10] [11].

RESULTS AND DISCUSSION

Exploration of Gandrung Jejer Jaran Dawuk Dance Accompaniment

This research was conducted during the covid pandemic period which gave many obstacles because GJJJ dance performances were rarely done. So that data collection is mostly done in dance studios and traditional schools which also train the use of traditional musical instruments. The first informant was Sumitro Hadi, who composed the GJJJ dance and composed the accompanying music. The explanation of the musical instruments used to accompany the GJJJ dance is as stated in the GJJJ dance description [2].

The musical instruments used as an accompaniment to the GJJJ dance are two violins, two *kendangs*, two *ketuks*, two *gongs* (large and small), a *klunging*, and a set of *Banyuwangen gamelan* consisting of two *saron*, two *peking*, two *angklung*, and two *selentem*. The musical instrument that accompanies the GJJJ dance can be seen in figure 2.



FIGURE 2. GJJJ Dance Accompaniment Music

Sumitro Hadi also explained the GJJJ dance accompaniment notation. The *Banyuwangen* tone (Banyuwangi music) has only the following notes : do (*ji*, the name for *siji* or one), re (*ro*, penyebutan untuthe name for *loro* or two), mi (*lu*, the name for *telu* or three), sol (*mo*, the name for *limo* or five), la (*nem*, the name for *enam* or six). These notes are called *selendro Banyuwangen*. The musical notation that accompanies the GJJJ dance according to the first informant is as in Figure 3 below.

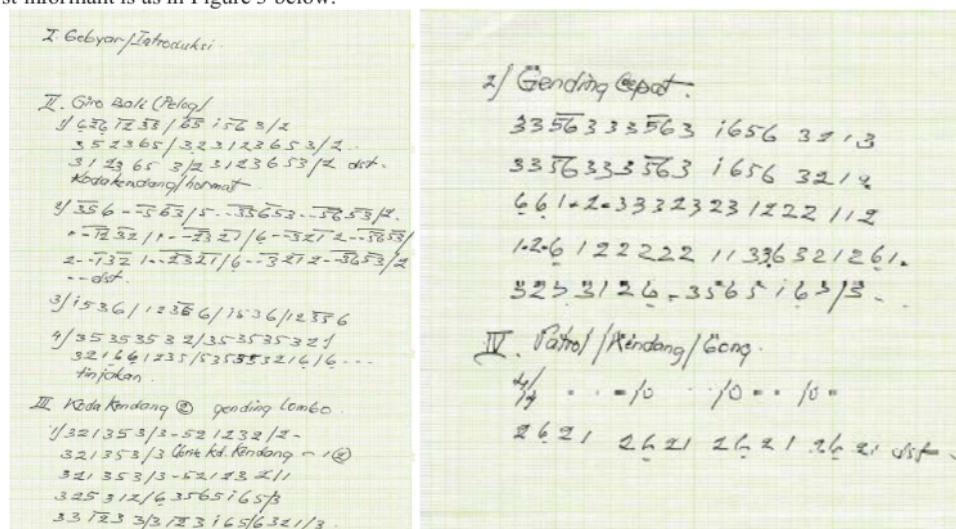


FIGURE 3. Music Accompaniment of GJJJ Dance According to the First Informant

The musical notation is only written in general because the first informant did not understand musical notation. He composed the accompanying music by humming his music, which was understood and embodied by the *panjak* who were accustomed to playing traditional Banyuwangi music. Meanwhile, the second informant, who is a musical

instrument maker, trainer, as well as a music player (*panjak*), can write down the musical notation for the GJJJ dance accompaniment as shown in Figure 4 below.

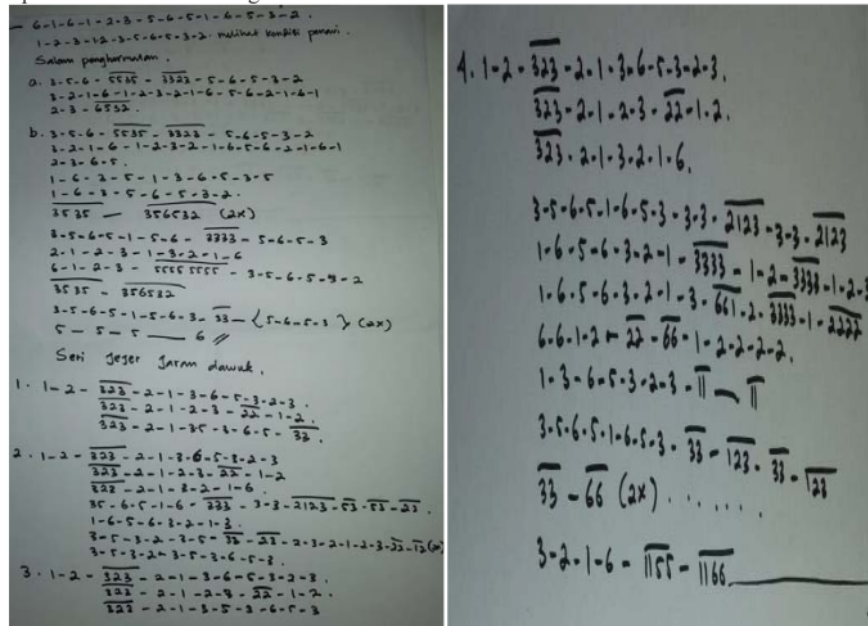


FIGURE 4. Music Accompaniment of GJJJ Dance According to the Second Informant

The notation in Figure 3 and Figure 4 is commonly used as a guide in the *Banyuwangen gamelan* which has a *selendro* tone. As for other musical instruments, it adapts to the *gamelan* playing. The musical notation in Figure 4 can be described as a diagram as follows in figure 5.

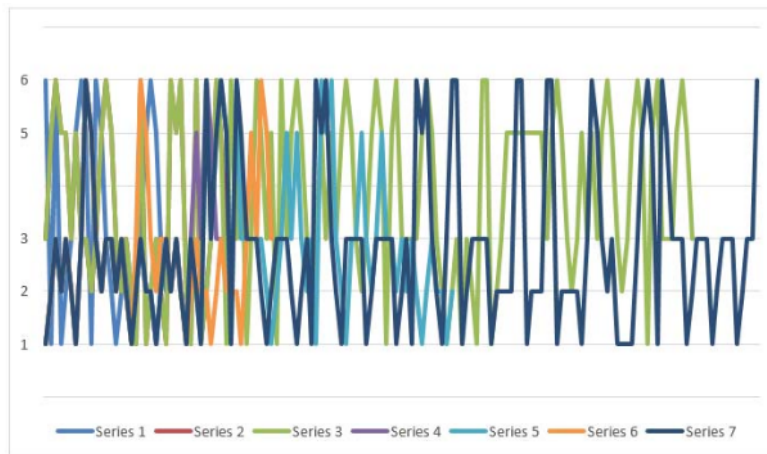


FIGURE 5. Overview of GJJJ Dance Accompaniment Notation in Graphic Form

The depiction of the GJJJ dance accompaniment music notation in figure 5 shows the principle of symmetry and self-similarity which is a feature of fractal geometry. However, determining the fractal dimension is considered quite difficult to do. This is because identifying fractals in music requires a different approach compared to looking at an image where the structure can be seen immediately [12]. A study of fractal-based curves in musical creativity suggests that fractal dimensions in music may not exist as non-integer [13]. This contrasts with other studies which

state that the fractal dimensions of traditional music are $N = 18$, which is almost the same as electronic music with fractal dimensions $N = 19$ and concert music with fractal dimensions $N = 16$ [14].

The Banyuwangi *gamelan* consists of *selentem/panthus*, *saron*, *peking*, and *angklung* as shown in figure 6. *Selentem*, *saron*, and *peking* are musical instruments consisting of blades made of iron and mounted on wooden frames.

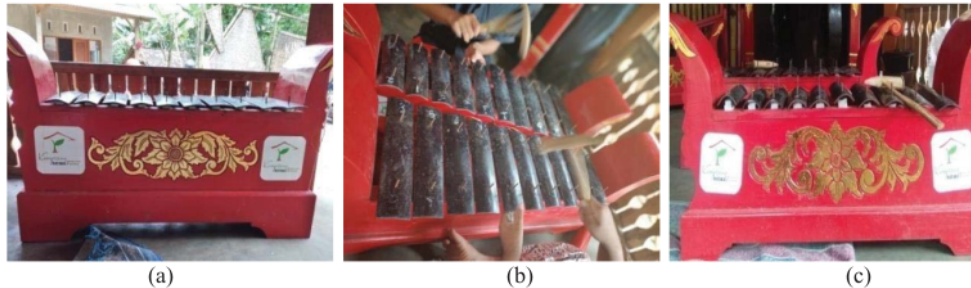


FIGURE 6. (a) *Selentem*, (b) *Saron*, (c) *Peking*

Figure 7 (a) shows that each *selentem*, *saron*, and *peking* have ten blades in the order of notation. The length of each iron blade varies depending on the *gamelan* maker. The first three bars represent the lower notes (*lu*, *mo*, *nem*), followed by five for the normal notes (*ji*, *ro*, *lu*, *mo*, *nem*), and two for the high notes (*ji*, *ro*). *Selentem*, *saron*, and *peking* are played by beating them using a wooden club with a shape resembling a tube (as shown in Figure 7 (a)).

The wooden frame supporting the *gamelan* is made a hole in the middle (Figure 7 (b)) so that when the *gamelan* is struck it does not cause an echo, but the sound produced is still loud. *Selentem* has the most horizontal blade shape, *saron* has a more curved blade shape when compared to *selentem*. While *peking* has the most curved blades resembling a semicircle. The curvature of the *gamelan* blades influences the sound of the *gamelan*. So the sound of *saron* is a normal voice, while *selentem* has a low voice and *peking* has a high voice. This means that the more curved the iron blade, the higher the sound produced.



FIGURE 7. The Sequence of Notation on Ten Blades of Banyuwangi *Gamelan*.

When viewed from above (as in Figure 7 (a)), each blade of *selentem*, *saron*, and *peking* resembles a rectangular shape. The arrangement of the iron blades is positioned parallel as well as lines that do not intersect or cross. The length of each blade has a certain size that is adjusted so as not to change the pitch and resonance of the sound. This is by previous studies which showed that the longer the blades in a *gamelan* would lead to lower tones and longer resonances, and vice versa [15]. Meanwhile, if you look at it from the side (as in Figure 6), each blade shows a difference in level, as discussed in the previous paragraph. The support for each *gamelan* shows the shape of a space resembling a beheaded prism.

Angklung is a musical instrument with a blade made of bamboo and a frame made of wood. The main key in playing *angklung* is memorizing and understanding the song to be played. As a companion in the GJJD dance, it takes two *angklung* that are played together and mutually, called *kelencangan*. The tone of banyuwangi *angklung* is the same as *selentem*, *saron*, and *peking*, such as do (*ji*), re (*ro*), mi (*lu*), sol (*mo*), la (*nem*). As a result, the banyuwangi *angklung* can only be used to accompany Banyuwangi songs.



FIGURE 8. Banyuwangi Angklung

Angklung in Banyuwangi, as seen in figure 8, has fifteen bamboo blades, each of which resembles a tube shape. The fifteen blades consist of five low rhythm blades (*lu, mo, nem, ji, ro*), five normal rhythm blades (*lu, mo, nem, ji, ro*), and five high rhythm blades (*lu, mo, nem, ji, ro*). Each blade will make a sound when struck with two bats made of wood in the shape of a small tube.

The length of each bamboo blade on the angklung differs depending on the angklung maker. This means that there is no mandatory basis for determining the length of bamboo blades. But the length of the bamboo blade is getting shorter from left to right. So the shorter the bamboo blade, the higher the sound. Angklung makers generally carry out the process of equating the diameter and length of the bamboo that will be used as an angklung blade with the size of the finished bamboo using traditional unit concepts such as *sak kilan*, *sak nyengking*, and finger diameter [16].

The arrangement of the bamboo blades is positioned like a parallel line. The angklung supports have a trapezoidal shape, each angklung blade has a circular surface, while the angklung blades and the bat have a tube shape. This is by previous studies which showed the trapezoid concept on the angklung support, the circle concept on the angklung blade, and the tube concept on the angklung blade and the beater [16].

The violin is a musical instrument that must exist in Banyuwangi traditional music performances. In the music for GJJJ dance, the violin is used with a tone that matches the *gamelan* playing. The violin has four basic notes, namely G, D, A, E, which are the same as the basic notes of the violin in general. The difference between the Banyuwangi violin and the one commonly used is that the four tones are lowered (the strings are set at a low pitch) to match the tone played by the *gamelan* and the song being sung. In addition, the Banyuwangi violin string pattern is performed on two strings at once, giving rise to a double tone sound.



(a) (b)
FIGURE 9. Violin : (a) Front look, (b) Back view

The violin is a stringed instrument that has a shape resembling a prism. The top and base surfaces of a prism are plane shapes with regular curved sides, as we can see in figure 9 (a) and (b). The four strings representing the notes G, D, A, and E resemble four lines that meet a point at the end of the violin. The string key is located at the end of the violin with a symmetrical position to the right and left (two each).

Kendang is a percussion instrument that has a role in the GJJJ dance. At some intervals of dance movements, there is a *koda kendang*, meaning that there is a *kendang* game that becomes the code for the dancer to make the next movement. They are two sizes of *kendang*, namely large (*kendang wadon*/female) and small (*kendang lanang*/male). Both types of *kendang*s are shown in figure 10. *Kendang wadon* is used as a compliment, while *kendang lanang* is the main *kendang* in the GJJJ accompaniment music. The size of *kendang lanang* and *kendang wadon* depends on the maker (no mandatory size). Each *kendang* has two circular surfaces (large and small). The

two surfaces have different sizes. So that the shape of *kendang* is more like a beheaded cone, not a tube. This is by previous research which mentions the concept of a circle and a beheaded cone on *kendang* [15] [17].



FIGURE 10. *Kendang Lanang* (left) and *Kendang Wadon* (right)

Playing *kendang* must pay attention to playing other musical instruments because *kendang* is complementary to certain parts in accompanying the GJJD dance. Playing *kendang* on the GJJD dance accompaniment is done with a hard blow. The strokes on *kendang lanang* are carried out on both surfaces, while the punches on *kendang wadon* are carried out only on the large surface. There are five ways to hit *kendang lanang* as shown in Figure 11.

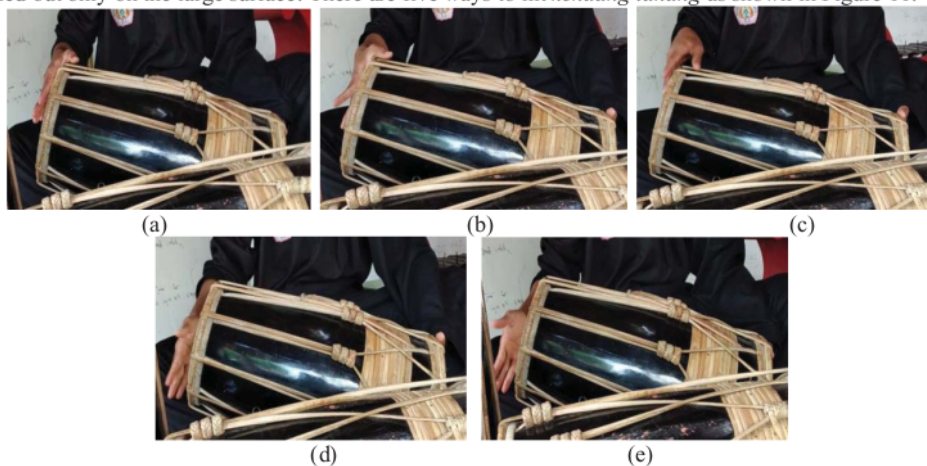


FIGURE 11. Five Ways to Hit *Kendang*

The strokes on *kendang* do not follow the notation used in the *gamelan*. The *kendang* player must have the skill to hit *kendang* to match the tone produced by other musical instruments.

Not only *kendang*, but *kluncing* is also a distinctive musical instrument that should not be abandoned. *Kluncing*, as shown in figure 12, is a percussion instrument made of iron which is shaped like a triangle. More specifically, in previous studies, it was mentioned that *kluncing* has a shape resembling an isosceles triangle [15]. The bat is also an iron that resembles a tube.



FIGURE 12. *Kluncing*

Kluncing is played by hitting a long iron (batter) against a triangular iron in harmony with the rhythm produced by the *gamelan*. *Panjak* (player) *kluncing* is in charge of giving directions to GJJJ dancers during the intermission of the accompaniment music, which is called *kudangan kluncing*.

Gong is a percussion instrument made of iron. There two *gongs* used, namely *gong kung* (small) and *gong gol* (large). The *gong* is played without notation but adapts to *gamelan* and violin. The *gong* is hit with a bat made of wood wrapped in cloth (as shown in Figure 13 (b)).

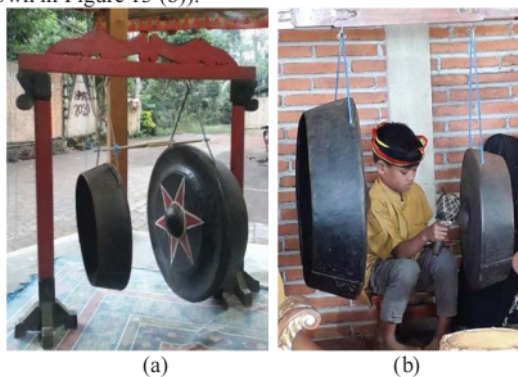


FIGURE 13. *Gong*

Gong has a surface resembling a circle. While the overall shape of the *gong* is a hollow shape resembling a beheaded cone. This is by previous research which mentions the concept of a beheaded cone on the *gong* [15]. The two *gongs* are not the same size, so they appear to be similar with a certain size ratio.

The last musical instrument used is *ketuk*. *Ketuk* is similar in shape to the *gong* but in a much smaller size. So that *ketuk* also has a surface shape resembling a circle and as a whole is a hollow space shaped like a beheaded cone, as we can see in figure 14. This is following the results of previous studies which showed the concept of a circle on a percussion-like *ketuk* [18] and a beheaded cone [15].



FIGURE 14. *Ketuk*

Ketuk is not hung like a *gong*, but is placed on the floor and played by hitting it. Beaters are usually made of wood or bamboo. There are two *ketuks* needed in the GJJJ dance accompaniment with different sizes. The difference appears as a similarity shape with a certain size ratio.

Geometry Learning Based on *Gandrung Jejer Jaran Dawuk* Dance Accompaniment Music

The results of the exploration of GJJJ's dance accompaniment music show that there are various geometric concepts both in musical instruments and in musical notation. These concepts include two-dimensional figures (rectangles, trapezoids, circles, semi-circles, and triangles), three-dimensional figures (prisms, beheaded prisms, and beheaded cones), parallel lines, similarity, and fractal geometry. These concepts can be the basis for learning geometry in primary, secondary, and higher education.

The basics of geometry are part of teaching visualization to students in basic education. Visualization is the lowest level in geometric thinking, that begins with a nonverbal process through identifying, comparing, and operating geometric shapes such as triangles, angles, or intersections, according to their appearance [19]. Students

with less visual competence will face problems in solving geometry problems in particular, as well as mathematics in general [20].

To be able to identify the shape, position, and condition can be done with musical instruments to accompany the GJJD dance. For example, rectangular and trapezoidal shapes on *gamelan* (figure 15), circles on *gongs*, *ketuk*, and *kendang* (figure 16), triangles on *kluncing*, parallel lines positions on *gamelan* and *angklung* (figure 17), intersecting lines on violin strings (figure 18), the similarity of circles on the surface of *gongs*, *ketuks*, and *kendangs*, and so on.



FIGURE 15. (a) Trapezoid Visualization and (b) Rectangle Visualization



FIGURE 16. Circle Visualization and Circle Similarity



FIGURE 17. Parallel Line Visualization



FIGURE 18. Intersecting Line Visualization

This visualization ability will make it easier for students to carry out geometric thinking processes at the next levels. An understanding of geometry starting from basic education is important because of its influence not only in the mathematics learning process but also in other subjects, as well as in daily life needs. This makes geometry an important component in the primary and secondary school curriculum, even becoming one of the most complex parts of the curriculum [20].

As for the visualization and theory in fractal geometry, it is easier to understand at the higher education level. One of the reasons is because fractal geometry helps explain things and situations that cannot be explained in

Euclidean geometry [21], while students in primary and secondary education are still in the process of understanding Euclid's geometric concepts. For this reason, the concept of fractal geometry in GJJJ dance music can be given in higher education.

This discussion shows that music can be a basis for designing geometry lessons at various levels of education. The unique features that exist in music can be a resource for students to make connections in learning, as well as a way to represent mathematics in different alternatives [9]. But all of that still requires more ability from the teacher to be able to integrate music in learning geometry.

CONCLUSION

Geometry as part of mathematics is one of the concepts that require more understanding from the beginning (visualization) so that further thinking processes can be more easily carried out. Geometry is contained in the music, especially the music for the *Gandrung Jejer jaran Dawuk* (GJJJ) dance. These concepts include two-dimensional shapes (rectangles, trapezoids, circles, semicircles, and triangles), three-dimensional shapes (prisms, beheaded prisms, and beheaded cones), parallel and intersecting lines, similarity, and fractal geometry. In this study, these concepts can be developed into the basis of visual geometry learning. The next research can be done to develop geometry learning based on GJJJ dance music in the form of analysis and problem-solving.

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Profound thanks and appreciation are given to Banyuwangi artists, especially to the late Mr. Sumitro Hadi who passed away on December 26, 2020. Hopefully, Banyuwangi culture can continue to be explored and integrated into learning at every level of education.

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