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Javanese Culture as An Object of Ethnomathematics In The Development of E-LKPD Online Learning Era 4.0

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Abstract

Ki Hadjar Dewantara taught the spirit and how to educate Indonesian children to become independent human beings. This policy provides convenience in online learning conditions with all the limitations of space. Various content available in cyberspace allows students to do more online activities. If there is no self-monitoring and awareness, online activities will actually erode the values of the nation's noble cultural character. Considering the importance of ethnomathematics to the formation of students' noble cultural characters, a study was conducted that aims to develop an online inquiry learning model based on Javanese Cultural Ethnomathematics in Era 4.0. The research conducted is in the form of research and development which consists of five stages referring to the educational development model of Plomp. The results of the research have been carried out until the first stage, namely field observations, literature studies and FGDs. Field observations were carried out by observing 10 (ten) cultural sites located in the Provinces of the Special Region of Yogyakarta (DIY), Central Java, and East Java. The results of observations and FGDs show that out of ten cultural sites have unique ethnomathematical characteristics, but broadly speaking, ethnomathematical elements related to geometric concepts can be divided into plane geometry and spatial geometry.

Keywords: Javanese Culture, Ethnomathematics, E-LKPD, Online Learning

Introduction

The changing world is now entering the era of the industrial revolution 4.0 where information technology has become the basis of human life. Era 4.0 is a period in which information technology is growing rapidly and has become a human need in all parts of the world. Technological advances affect all sectors, including education. The use of digital media in education is very well accepted by all circles.

As if synergizing with these conditions, the Covid-19 pandemic has resulted in changes in the order of human life, including in learning activities. All learning activities are carried out online by utilizing information technology and internet networks (Sadikin & Hamidah, 2020). Online learning has its own challenges in its implementation, including increasing student activity, understanding concepts and thinking processes. The inquiry learning model is able to provide students with relevant experiences, help them apply scientific methods, train and develop relevant skills (Arslan, 2014; Gunawan, et al., 2019). Inquiry learning allows students to build knowledge independently and helps them develop an understanding of representative concepts and practice scientific literacy (Wilson et al., 2010; Suhada, 2017). The other side, online learning makes it more likely to implement the independent learning program launched by the Ministry of Education and Culture.

The term independent learning has long been echoed by the Father of National Education through the teachings of Tamansiswa. Through freedom of learning, Ki Hadjar Dewantara teaches the spirit and ways of educating Indonesian children to become human beings who are free in mind, free in mind, and

free in body/energy. This policy is certainly very easy to feel especially in conditions of online learning with all the limitations of space. Through this policy, schools can use a curriculum that adapts to the learning needs and conditions of students.

The amount of interesting content available in cyberspace allows students to do more online activities. If there is no supervision from parents, as well as personal awareness to limit oneself, internet use will actually have a negative impact, including the erosion of the nation's noble cultural character values. This happens because of the lack of application and understanding of the importance of cultural values in society. The erosion of the value of this cultural character is seen by current phenomena such as the amount of violence, riots, self-destructive activities, juvenile delinquency, and so on.

Cultural values as the foundation of the nation's character need to be instilled from an early age so that each individual is able to better understand, interpret, and appreciate and realize the importance of cultural values in carrying out every activity of life. Cultivation of cultural values can be done through the family environment, education, and society, not least through learning mathematics.

Cultural elements can be brought to mathematics learning through ethnomathematics (Rahmawati & Muchlian, 2019). Ethnomathematics is a way of expressing mathematical concepts that grow in various aspects of students' lives and contextual experiences (Rosa & Orey, 2011; Widada, et al., 2018). Ethnomathematics can be studied very broadly and deeply. In this study, the study focused on the ethnomathematics of Javanese culture. Javanese culture is a culture that originates from Java and is embraced by the Javanese people, especially in Central Java, Yogyakarta, and East Java. Javanese culture can be studied from the point of view of literature, language, kingdom, architecture, calendar, and art. In this research, Javanese culture is focused on the study of architecture by applying it to the concept of geometry.

Through Javanese culture, noble values can be obtained that can be used as a source of universal character education (Budiyono & Feriandi, 2017). Given the importance of ethnomathematics to the formation of the noble cultural character of students in the 4.0 era as well as in the midst of a pandemic with the implementation of online learning policies, a study was conducted that aims to develop an online inquiry mathematics learning model based on Javanese Cultural Ethnomathematics in Era 4.0.

Method

The research conducted is in the form of research and development which refers to the educational development model of Plomp (Plomp, 1997). The research stages include: (1) Initial Investigation Phase, (2) Design Phase, (3) Realization/Construction Phase, (4) Test, Evaluation, and Revision Phase, and (5) Dissemination and Implementation Phase. The details of the description of the activity stages are described as follows.

Phase 1 includes field observations, literature studies and FGDs. Field observations were carried out through observations at 10 (ten) cultural sites located in the Provinces of the Special Region of Yogyakarta (DIY), Central Java, and East Java. Stage 2 is carrying out the design stage by designing learning models including instructional model guidebooks, compiling learning tools and compiling research instruments.

Stage 3 is the realization/construction by carrying out small-scale trials and large-scale trials by carrying out online learning using the learning model that has been developed. Stage 4, namely tests, evaluations, and revisions by carrying out tests on all students as research subjects and collecting data. The last research stage is dissemination and implementation by carrying out online learning with an online inquiry mathematics learning model based on Javanese Culture ethnomathematics in Era 4.0 according to the guidelines that have been prepared. This research is focused on the first stage.

Data collection techniques in this study are test techniques, online questionnaires, and observation. The implementation of the test uses a concept understanding test instrument, the technique of filling out a questionnaire using a questionnaire via a google form, while the observation uses a learning implementation form. From the data collection, the test results data, questionnaire results data and observation results were obtained. The data were then analyzed using quantitative descriptive analysis techniques.

Results and Discussion

This research has been carried out until the first stage, namely field observations, literature studies and FGDs. Field observations were carried out through observations at 10 (ten) cultural sites located in the Special Region of Yogyakarta (DIY), Central Java, and East Java. The ten cultural sites are the Yogyakarta Palace (DIY), “Museum Kereta” of Yogyakarta Palace (DIY), Prambanan Temple (DIY), Ratu Boko Site (DIY), Yogyakarta Kekayon Puppet Museum (DIY), Surakarta Palace (Central Java), Borobudur Temple (Central Java), Dieng Temple (Central Java), Trowulan Site (East Java), and Wringin Lawang Gate (East Java).

Due to the pandemic conditions, observations were carried out both in person and online/virtually. Several cultural sites that can be directly observed prior to the implementation of Large-Scale Social Restrictions (PSBB) include the Yogyakarta Palace, Yogyakarta Palace Train Museum, and Ratu Boko Site, while observations on other cultural sites are carried out through searching for information on the official website, YouTube, brochures. , and other electronic sources.

The results of subsequent observations are used as the basis for the implementation of the FGD. FGD focused on identifying ethnomathematical objects found on cultural sites as well as determining the syntax of the learning model to be developed. Each cultural site has different characteristics, including ethnomathematical objects that can be explored in it. The identification of ethnomathematical objects obtained from observations at ten Javanese cultural sites focused on architectural studies by applying the concepts of geometry. The full description is presented as follows.

The Yogyakarta Palace

The Yogyakarta Palace is the official palace of the Ngayogyakarta Hadiningrat Sultanate, which is located in the city of Yogyakarta, the Special Region of Yogyakarta, Indonesia. The palace building complex serves as the residence of the sultan and his palace household, which still carries out the sultanate tradition to this day. The palace is also one of the tourist attractions in the city of Yogyakarta. Part of the palace complex is a museum that houses various collections belonging to the sultanate, including gifts from European kings, replicas of palace heirlooms, and gamelan. Physically, the palace of the Sultans of Yogyakarta has seven core complexes, namely: *Siti Hinggil Ler* (North Hall), *Kamandhungan Ler* (North Kamandhungan), *Sri Manganti*, *Kedhaton*, *Kamagangan*, *Kamandhungan Kidul* (South Kamandhungan), and *Siti Hinggil Kidul* (South Hall). Almost all parts of the Yogyakarta Palace contain ethnomathematical elements related to geometric objects.



Figure 1. Gedhong Kaca and Bangsal Manis

The ethnomathematical elements in the geometric concepts found in the Yogyakarta Palace include rectangles (a), squares, rhombuses (c), triangles, trapezoids, parallelograms, circles (b), octagons. The geometry of space includes cubes, blocks, rectangular pyramids, prisms, cones, tubes, and spheres (Wijayanto, 2017).

Museum Kereta of Yogyakarta Palace

The Yogyakarta Palace Train Museum is a special museum that contains a collection of horse-drawn carriages belonging to the Yogyakarta Sultanate Palace. The museum is located around the Yogyakarta Palace area. This museum's collection of *kereta* is tens of years old or even more than a hundred years old. Some are still used in royal ceremonies. Based on the shape, the *kereta* belonging to the palace are divided into 3 types. The first is an open-top and two-wheeled train. An example of this type of *kereta* is the *Kereta Kapolitin*. The second type is an open-top and four-wheeled train, for example *Kyai Jongwiyat* and all *kereta* that use the Landower name. The last type is a closed roof carriage and four wheels, for example *Nyai Jimat*, *Kyai Garudayaksa*, and *Kyai Wimanaputra*.



Figure 2. *Kereta Kyai Jongwiyat*

The ethnomathematical elements in the geometric concepts contained in the *Museum Kereta* of Yogyakarta Palace include rectangles, squares, rhombuses, triangles (b), parallelograms, trapezoids, and circles (a). The geometry of space includes cubes, blocks, rectangular pyramids, prisms, cones and tubes (Setiana, et al., 2021).

Yogyakarta Kekayon Puppet Museum

The Kekayon Puppet Museum is a puppet museum located in the city of Yogyakarta. The museum, which was founded in 1990, has a collection of various puppets and masks and displays the history of wayang introduced from the 6th century to the 20th century. The puppets in this museum are made of leather, wood, cloth, and paper. This museum has several types of puppets, such as: *Wayang Purwa*, *Wayang Madya* (telling the post-war era of Bharatayuddha), *Wayang Thengul*, *Wayang Klithik* (telling Damar Wulan and Minakjinggo), *Wayang Beber*, *Wayang Gedog* (story of Dewi Candrakirana), *Wayang Suluh* (about history of the struggle for Indonesian independence), and others (Yogyakarta Special Region Cultural Office, 2014).



Figure 3. Entrance of the Kekayon Puppet Museum and Replica of the *Wayang Rama*

The ethnomathematical-based geometric objects found in the Wayang Kekayon Museum Yogyakarta are rectangles (a), squares, rhombuses, triangles, and circles. The geometry of space includes cubes, blocks (b), rectangular pyramids, and prisms.

Prambanan Temple

Prambanan Temple or Roro Jonggrang Temple is the largest Hindu temple complex in Indonesia which was built in the 9th century AD. This temple is dedicated to *Trimurti*, the three main Hindu gods, namely Brahma as the creator god, Vishnu as the guardian god, and Shiva as the destroyer god. This temple is a UNESCO World Heritage Site, the largest Hindu temple in Indonesia, as well as one of the most beautiful temples in Southeast Asia. The architecture of this building is tall and slender in accordance with Hindu architecture in general. The temple is decorated with narrative reliefs that tell of Hindu epics; Ramayana and Krishnayana. On the walls of the temple there are reliefs engraved on the inner wall of the fence along the gallery aisle that surrounds the three main temples.



Figure 4. Prambanan Temple and Temple Reliefs

Geometric ethnomathematics objects at Prambanan Temple are relatively the same as other cultural sites, including rectangles (b), squares, rhombuses, triangles (a), parallelograms, rhombuses, trapezoids, and circles. The geometry of space includes cubes, blocks, rectangular pyramids, prisms, cones, and spheres (Marsigit, et al., 2018).

Ratu Boko Situs site

Ratu Boko site or Ratu Boko Palace is an archaeological site which is a complex of a number of remnants of buildings located approximately 3 km south of the Prambanan Temple complex. This site displays attributes as a place of activity or a king's residence/residence site. Ratu Boko is thought to have been used by people in the 8th century during the Sailendra dynasty (Rakai Panangkaran) of the Medang Kingdom (Hindu Mataram Period). Judging from the pattern of laying the remains of the building, it is strongly suspected that this site is a former palace (king's palace). This opinion is based on the fact that this complex is not a temple or a building with a religious character, but a fortified

palace with evidence of remnants of fort walls and dry moats as defensive structures (Soetarno, 2002). Remains of residential settlements were also found around the location of this site.



Figure 5. Ratu Boko Palace Gate and Ratu Boko *Pendopo*

Geometric ethnomathematics objects found at Ratu Boko Site include squares (a), triangles (b), rectangles (c), rhombuses, parallelograms, trapezoids, and circles. The geometry of space includes cubes, blocks, rectangular pyramids (b), prisms, cones and tubes (Rani, 2018).

The Surakarta Palace

Keraton Surakarta Hadiningrat is the official Palace of the Surakarta Hadiningrat Sunanate which is located in Surakarta City. This palace was founded by Sri Susuhunan Pakubuwana II in 1744. The entire area of the Surakarta palace includes the entire area within the Baluwarti fort, *alun-alun Lor*, *alun-alun Kidul*, *gapura Gladak*, dan kompleks Masjid Agung Surakarta and the Surakarta Grand Mosque complex. This palace has a fraction, namely the Yogyakarta Hadiningrat Palace from the Yogyakarta Sultanate (Kingdom of Yogyakarta). The basic spatial patterns of the two palaces (Yogyakarta and Surakarta) have many general similarities. The division of the palace includes: *Alun-Alun Lor Complex*, *Pagelaran Sasana Sumewa*, *Siti Hinggil Lor*, *Kamandungan Lor*, *Sri Manganti Lor*, *Kedhaton*, *Kamagangan* dan *Sri Manganti Kidul*, *Kamandungan Kidul*, *Siti Hinggil Kidul* and *Alun-Alun Kidul*.



Figure 6. The Main Door of the Surakarta Palace and the Sangga Buana Stage

Relatively many geometric ethnomathematical objects are found in the Surakarta Palace including squares, rectangles (a), triangles (b), trapezoids (c), rhombuses, parallelograms, and circles. The geometry of space includes cubes, blocks (d), rectangular pyramids, prisms, and tubes.

Borobudur Temple

Borobudur is a Buddhist temple located in Borobudur, Magelang, Central Java. This stupa-shaped temple was founded by Mahayana Buddhists around the year 800 AD during the reign of the Syailendra dynasty. Borobudur is the largest Buddhist temple or temple in the world as well as one of the largest Buddhist monuments in the world (Soekmono, 1978). This monument consists of six square terraces on which there are three circular courtyards, the walls are decorated with 2,672 relief panels and originally there were 504 Buddha statues. Borobudur has the most complete and largest collection of

Buddhist reliefs in the world. The largest main stupa is located in the center and at the same time crowning this building, surrounded by three circular rows of 72 perforated stupas in which there is a Buddha statue sitting cross-legged in a perfect lotus position with the Dharmachakra mudra (turning the wheel of dharma).



Figure 7. Buddha statues and Borobudur Temple

Ethnomathematics objects at Borobudur Temple can be used as learning materials for geometry in plane geometry and spatial geometry (Utami, et al., 2020). Field geometry objects include squares, rectangles, triangles, trapezoids, rhombuses (a), parallelograms, and circles (b) (Kurniawan & Hidayati, 2020). The geometry of space includes cubes, blocks, cones, and cylinders.

Dieng Temple

The Dieng Temple Complex is a group of 7th century Hindu temple complexes located in the Dieng Plateau, Banjarnegara Regency, Central Java, Indonesia. This complex consisting of several buildings comes from the Kalingga Kingdom (George, 1968). This highland area is home to eight small Hindu temples which are one of the oldest surviving religious buildings ever built in Java. The complex is the oldest known menhir building in Central Java (Romain, 2011; Jordaan 1999). It was originally estimated that there were as many as 400 temples, but only eight remain today. The temple architecture of the northern part of Central Java is famous for its smaller size, simplicity, and relatively less ornamentation (Soekmono, 1988). The earliest use of Javanese mask architecture and the sea monster Makara are shown along the niches and entrances of the remaining buildings (Michele, 1977).

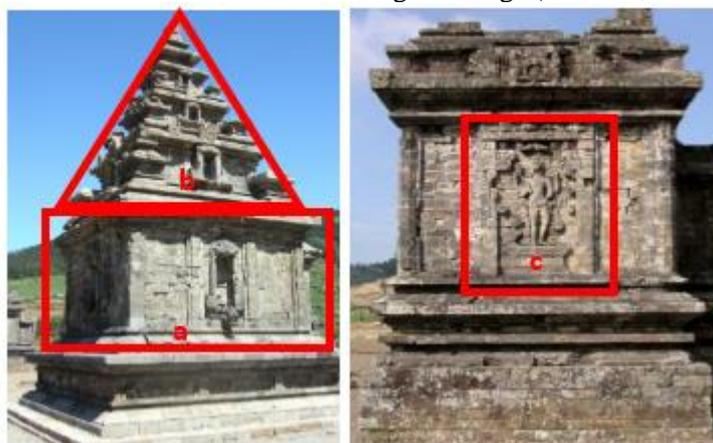


Figure 8. Arjuna Temple and Gatotkaca Temple

Geometric ethnomathematical elements that can be explored in Dieng Temple are rectangles (c), squares, triangles, and trapezoids. The geometry of space includes cubes, blocks (a), rectangular pyramids (b), and prisms. It can be said that the geometric object in Dieng Temple is a flat plane (Mahmudati & Lailiyah, 2020).

Trowulan Site

The Trowulan site is an archaeological area from the classical period of Indonesian history located in Trowulan District, Mojokerto Regency, East Java. Various findings raised here show the characteristics of a fairly developed settlement. Based on chronicles, inscriptions, symbols, and records found around the area, it is strongly suspected that this site is related to the Majapahit Kingdom. Several archaeological sites are scattered in the Trowulan District. Some of these sites are in a state of disrepair, while others have been restored. Most of these ancient buildings are made of red brick. Some of the sites contained in the Trowulan Site complex include the Tikus Temple, Bajang Ratu Gate, Wringin Lawang, Brahu Temple, *Makam Putri Cempa*, Segaran Pond, Menak Jinggo Temple, *Watu Umpak* Site, *Makam Troloyo*.



Figure 9. Bajang Ratu Gate and Tikus Temple

Geometrical objects with ethnomathematical nuances at the Trowulan Site include rectangles, squares, triangles, trapezoids (a) and circles, while spatial geometry includes cubes, blocks, rectangular pyramids, tubes and prisms (Budiarto, 2016).

Wringin Lawang Gate

Wringin Lawang Gate is a 14th century Majapahit heritage gate located in Jatipasar, Trowulan District, Mojokerto Regency, East Java. In Javanese, Wringin Lawang means Banyan Door. The structure and function of this grand gate building is made of red brick with a base area of 13 x 11 meters and a height of 15.5 meters (Arnawa, 1998). It is thought to have been built in the 14th century. This gate is commonly called the Candi Bentar style or the split gate type. This architectural style is thought to have emerged in the Majapahit era and is now commonly found in Balinese architecture. This gate is the entrance to an important building complex in the capital city of Majapahit.



Figure 10. Wringin Lawang Gate

Ethnomathematical objects that can be extracted from the Wringin Lawang Gate which is also a part of the Trowulan Site include rectangles, squares, triangles, and trapezoids, while for spatial geometry includes cubes, beams, rectangular pyramids, and prisms.

Conclusion

Based on the data analysis and discussion above, it can be concluded that from ten Javanese cultural sites, relatively many mathematical concepts can be identified in plane geometry and spatial geometry, including the concepts of triangles, squares, rectangles, rhombuses, parallelograms, trapezoids and circles. The concepts of spatial geometry that can be explored are beams, cubes, rectangular pyramids, prisms, tubes, spheres, and cones. This indicates that mathematics is close to culture and everyday life. This research is still in the field observation stage to identify mathematical objects. The identification results are then used as a basis for implementing the design phase, namely the preparation of products, learning tools, and research instruments based on Javanese Culture ethnomathematics. Javanese culture that contains elements of mathematics in it can be used as learning materials in schools as an alternative to learning materials outside of textbooks.

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