Exploration of Ethnomatscience in Sonobudoyo Museum Yogyakarta and Implication in Mathematics and Science Learning

Anggi Erna Aryani[1], Subekti Anjarwati[1], Yusinta Dwi Ariyani[1], Ruwet Rusiyono[1], Ika Noviatun[1], Ahmad Anis Abdullah[1*]

[1] Universitas Alma Ata, Yogyakarta, Indonesia
ahmad.anis@almaata.ac.id

Abstract. International assessments by the Organization for Economic Cooperation and Development (OECD) related to mathematics, science, and reading literacy in the 2018 Programme for International Student Assessment (PISA) score placed Indonesia 70th out of 78 countries. This shows that Indonesian students' ability to solve math and science problems is still very low. The characteristics of the Merdeka Curriculum are project-based learning, focus on essential material, and flexibility for teachers to carry out differentiated learning. One of the approaches that implement the Merdeka Curriculum is a contextual approach, namely the learning process of mathematics and science that is related to culture, also known as ethnomathscience. This study aims to explore the concept of ethnomatscience contained in Sonobudoyo Museum and the implications for learning math and science. This research is descriptive research with an ethnographic approach. Based on the results of observations and literature studies, several concepts of mathematics and science are found in the collection objects at Sonobudoyo Museum. The concepts of mathematics and science contained in the collection objects at Sonobudoyo Museum include counting, measuring, shapes such as pentagon, square, rectangle and others, as well as materials used for making batik, preserved flora and fauna, friction force, the concept of parabolic motion on catapults, the concept of circular motion on tops, and various other concepts. ethnomatscience concepts contained in Sonobudoyo Yogyakarta Museum can be used as learning math and science in schools in the form of learning media and text books.

Keywords: Ethnomatscience, Ethnomathematics, Ethnoscience, Sonobudoyo Museum.

1 Introduction

Education as the frontline that determines the progress and decline of a country is required to aggressively strive to improve quality in order to produce a generation that is ready for all competition and change. But in reality, the quality of education in Indonesia is still in a state of concern [1]. International assessments by the Organization for Economic Cooperation and Development (OECD) related to mathematics, science, and

© The Author(s) 2025
K. S. Rouzi et al. (eds.), *Proceedings of the 1st Alma Ata International Conference on Education (AAICE 2023)*, Advances in Social Science, Education and Humanities Research 920,
https://doi.org/10.2991/978-2-38476-414-3_6

reading literacy in the 2018 Programme for International Student Assessment (PISA) score put Indonesia in 70th place out of 78 countries [2]. This shows that Indonesian students' ability to solve math and science problems that require research, reasoning, and effective communication, as well as the ability to solve and interpret problems in various situations is still very low.

The mastery of knowledge that is the main aspect in the international assessments of both PISA and TIMSS is the ability of mathematics and science literacy. Mathematics and science literacy emphasizes the use of mathematics and science in everyday life. However, in reality, students are not familiar with non-routine problems, students are more interested in solving problems according to the material but lack understanding of contextual problems [3].

The ability to solve problems in everyday life is one of the main objectives of learning mathematics and science. This is in line with the learning process in the Merdeka Curriculum, which was previously known as the Prototype Curriculum and then developed as a more flexible curriculum framework, which also emphasizes essential material and the development of student character and abilities. According to the characteristics of this curriculum, what supports learning recovery is project-based learning, focus on essential material, and flexibility for teachers to carry out differentiated learning. One of the approaches that implement the Merdeka Curriculum is a contextual approach, namely the learning process of mathematics and science that is related to culture, also known as ethnomatscience.

Local culture is a real form that can be found in everyday life and can be used for contextual learning. Several studies related to local cultural heritage have been explored in the form of historical buildings, arts, and customs but are still limited to the context of mathematics only [4] or natural science only [5]. Meanwhile, the Merdeka Curriculum demands project-based learning, focus on essential material, and flexibility for teachers to carry out differentiated learning. Therefore, it is necessary to carry out an innovative learning activity, namely connecting teaching materials in students' daily lives through cultural means, namely learning through ethnomatscience learning.

ethnomatscience is one way of learning mathematics, physics, chemistry, and biology that is associated with culture. Thus, it can be said that the learning process of the Merdeka Curriculum which results in students being able to conduct research, reasoning, and effective communication, as well as the ability to solve and interpret problems in various situations can be realized. With ethnomatscience, students will tend to be more active because old learning that tends to be formal can be changed by linking it to everyday life. This concept can help students not get bored and not feel lazy with math and science lessons.

Sonobudoyo Museum is one of the historical cultures of Yogyakarta. This museum stores various collections of historical objects, the majority of which are closely related to the history of Javanese culture. Sonobudoyo Museum has facilities in the form of two museum units, unit 1 is located on Jl. Pangurakan No.6, Ngupasan, Kec. Gondomanan, Yogyakarta City, while Unit II is located at Ndalem Condrokiranan, Wijilan, east of the North Square of the Yogyakarta Palace. Until now, Sonobudoyo Museum is still seen from a cultural point of view only, even though the existence of Sonobudoyo Museum can be utilized for learning in schools seen from the form and constituent

materials. This research has the aim of exploring the concept of ethnomatscience contained in the Sonobudoyo Museum and the implications for learning math and science. The urgency of this research is to explore the concepts of math and science in depth at the Sonobudoyo Museum to be used as material for making local culture-based math and science learning media, with the hope that learning math and science will be more meaningful and interesting

2 Methods

This research uses a type of qualitative research with an ethnographic approach. The method used by researchers is a descriptive method with an ethnographic approach and a case study type about Sonobudoyo Yogyakarta Museum, in order to deepen the concepts of mathematics and science that exist in Sonobudoyo Yogyakarta Museum. For data collection techniques that researchers use in this study are observation, interviews, literature studies, and documentation. The results of observations and documentation are in the form of ethnographic notes (field notes), namely writings made during observation and documentation activities [4], while literature studies obtained from books, journals, and other literature sources related to the Sonobudoyo Yogyakarta Museum. After the data is obtained, data analysis is then carried out [6]

Data analysis in this study includes domain analysis and taxonomy analysis. Domain analysis is carried out to obtain a general and comprehensive description of the research object along with determining the category/domain and grouping the data according to the category/domain [7]. In this study, data related to mathematical ideas were grouped according to five categories/domains, namely ethnomathematics domains such as algebra, geometry, calculus and others. Then data related to science ideas were grouped according to the categories/domains of chemistry, physics, and biology consisting of healthy food, digestion, substances used, natural resources, motion and others. Furthermore, taxonomic analysis is carried out by describing the selected domains into more detail based on the concepts of mathematics and science contained in the Sonobudoyo Museum section which is displayed in tabular form. The math and science concepts referred to in this study are the math and science concepts contained in the 2013 Curriculum.

The implementation of this activity has several stages, namely: (a) The planning stage, including: preliminary observations, making proposals, submitting research proposals and making research instruments; (b) The implementation stage, including all activities carried out at the research site, such as data collection, data processing, data analysis and conclusion drawing; and (c) The completion stage, including the preparation of research reports, preparation of articles and publication of scientific articles.

3 Result and Discussion

A museum is a place used to store valuable objects, historical objects, and rare objects. Museums can also be interpreted as a representation of past events that can be remembered and become lessons for the future. Museums as historical heritage have an important role in education. Museums can be used as learning media due to the complexity of the media available as a depiction of an event. This provides various conveniences for students in understanding the objects on display. The convenience obtained by students is because the museum has provided various media that provide a lot of information.

One of the museums that can be used as learning media is Sonobudoyo Museum. Sonobudoyo comes from the word sono which means place and budoyo means culture. This museum was formerly a foundation engaged in the field of culture, namely the culture of Java, Madura, Bali and Lombok which was established in Surakarta in 1919 called Java Institut. Precisely in 1924 through the congress decision in 1924 Java Institute will establish a museum in Yogyakarta.

Sonobudoyo Museum is a museum that stores various collections of historical objects, the majority of which are closely related to the history of Javanese culture. Sonobudoyo Museum has facilities in the form of two museum units, unit 1 is located on Jl. Pangurakan No.6, Ngupasan, Kec. Gondomanan, Yogyakarta City. While Unit II is located at Ndalem Condrokiranan, Wijilan, east of the North Square of the Yogyakarta Palace. Sonobudoyo Museum Unit I has several other cultural collections such as Balinese and pre-historic cultures. While the Sonobudoyo Unit II Museum stores various interesting collections in the form of cultural products typical of DIY Province. The museum building was originally the residence of Adipati Anom Kanjeng Sultan Hamengkubuwono III. The typical Javanese atmosphere is clearly visible from the shape of the museum, from the cepuri which has a pyramid roof with a semi tinaduh, goyo, and bandogo structure. The current status of Sonobudoyo Museum also functions as a tourist attraction managed by the UPTD of the DIY Culture and Tourism Office. The basis for this is contained in the Decree of the Governor of DIY No. 90 of 2004 Cultural Service. Currently, the Sonobudoyo Museum is led by Bp Setyawan Sahli S.E, M.M (as of December 2020).

Sonobudoyo Museum offers collection objects which are divided into 10 types of collection objects, consisting of: 1) Geological collections, in the form of objects that are the object of geological science such as rocks, fossils, and other geological objects; 2) Biological collections, such as preserved animals etc.; 3) Ethnographic collections, in the form of collections of the results of a culture or that illustrate the identity of an ethnicity; 4) Archaeological collections, in the form of pre-historic objects and their culture; 5) Historic collections, in the form of collections of objects of historical value; 6) Numismatic collections, consisting of currency / currency used by the community in the past, in the form of coins - metal coins used during the kingdom; 7) Philologic collections, namely collection objects that are the object of philological research, such as manuscripts and ancient writings; 8) Keramologic collections, namely collection objects made of burnt clay (ceramics and pottery); 9) Art collections, in the form of two

and three-dimensional works of art; 10) Technology collections, in the form of collections of objects that illustrate the development of technology in their time, such as weapons and other tools.

Sonobudoyo Museum is one of the museums in Yogyakarta that can be used as a learning resource. This is because in the museum there are various collection objects that can be used to support learning, especially learning math and science. For example, biology collections such as preserved animals, art collections, such as masks, batik paintings, and other objects that can be used for math teaching materials, and technology collections for their application in physics learning and other collections that can be used as learning media, especially learning math and science.

If you pay further attention, the Sonobudoyo Museum contains various elements of ethnomatscience including counting, measuring, designing, playing, and explaining. For the concept of biology is found in the collection of flora and fauna. For the chemical concept, there are substances used to preserve objects in the museum. As well as for the concept of physics contained in the technology collection, for example in the concept of light. This proves that Sonobudoyo Museum can be used as a medium for learning math and science as well as learning to appreciate local cultures as a form of nationalism towards the nation. Similarly, seeing pictures of historical objects can add clarity about the history of historical objects. This shows that the use of media determines student interest in learning [8].

Based on the results of the analysis of the Sonobudoyo Museum in Yogyakarta, there are parts that have aspects of math and science that can be related to math and science subject matter. The parts in the Sonobudoyo Museum related to Mathematics and science subject matter are the concept of rectangular pyramid on the roof of the Sonobudoyo Museum building, then the concept of reflection on the mask, the concept of curved side space on pottery, the concept of rotation and translation on batik motifs, the concept of tiling on woven bamboo, the concept of flat side shapes such as square, rectangle, rhombus and others, line concepts such as curved lines and parallel lines and many others. While the concept of science is in physics there is the concept of spring force, parabolic motion, moment of inertia, force and friction. Biology concepts are monocotyledonous and dicotyledonous plants, crosses, biodiversity, the concept of taproot and fibers, morphology and many more. While in chemistry concepts there are concepts of corrosion, redox reactions, elements and compounds and others. In addition, there are many more math and science concepts that can be used as learning materials for students.

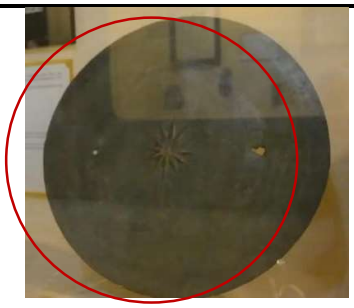
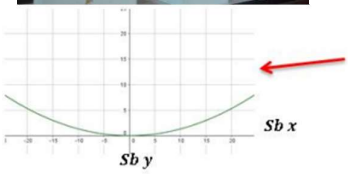
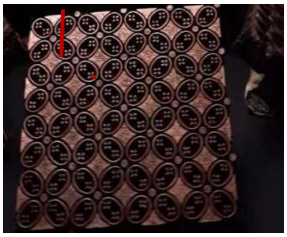
Some concepts of math and science lessons found in Sonobudoyo Museum can be taught to students. The role of math and science teachers is needed to transform culture-based math and science learning. Thus, ethnomatscience can be used for fun learning media to deliver math and science concepts against the background of local wisdom.

Table 1. List of parts of the Sonobudoyo Museum Yogyakarta.

Ethnomatscience	Domain	Implementation

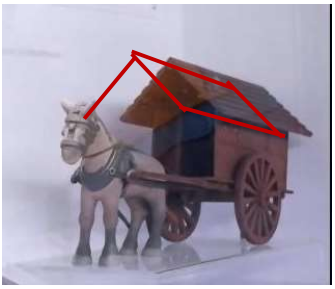
 Collection display	Mathematics (Concept of Square Flat Buildings)	One of the collection displays at the sonobudoyo museum has a square flat shape. A square is a two-dimensional flat shape formed by four equal-length ribs and has four angles, all of which are right angles [9].
	Mathematics (Concept of Rectangular Flat Buildings)	One of the musical instruments in the gamelan has a rectangular shape. a two-dimensional flat shape formed by two pairs of sides that are each equal in length and parallel to their partners, and has four angles, all of which are right angles [9].

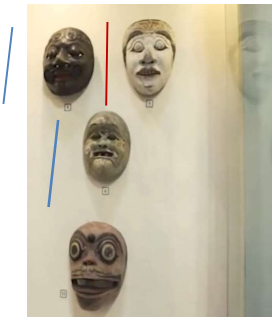
 The roof of Sonobudoyo Museum	Mathematics (Concept of Quadrilateral Pyramid)	On the roof of the Sonobudoyo Museum building there is a roof in the form of a rectangular pyramid. A rectangular pyramid or rectangular pyramid is a space bounded by a rectangular area and four triangular areas that have one common corner.
 Collection display	Mathematics (Concept of Equivalence)	The display shows that there is a square that is congruent. Two flat shapes are said to be congruent if the corresponding angles are equal and the corresponding sides are comparable [10].
 Cups and teapots	Mathematics (Concept of Curved Side Spaces of Tubes)	In the glass and teapot there is a tube shape with an open roof. So in this case it includes a curved side space. The concept of curved-sided spaces is found in many wooden household decorations decorated with batik, such as teapots and glasses made from coconut shells.

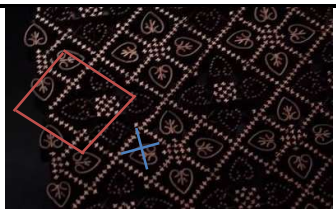
	Mathematics (Concept of Circle)	The collection object in the picture has a circle shape. Circle is one of the flat shapes. A circle is a collection of points that have a fixed distance to a certain point (O). Point O is called the center of the circle and the fixed distance is called the radius of the circle [11].
  kurva parabola	Mathematics (Concept of Parabolic Curve)	The shape of the jug is a parabolic curve. the shape of the jug pottery is a slice of a cone with a parabolic shape and with a circle added as the lip of the pottery. A parabola is the position of points whose distance to a certain point, called the focal point (f), and a certain line, called the directrix (d), is always the same. (Because e = 1) [12].
	Mathematics (Concept of Reflection or Mirroring)	In the concept of the batik pattern there is the concept of reflection. In the batik pattern there is a transfer of objects using mirroring, namely a flat mirror so that it produces the same shadow. So that the batik pattern is included in the

		concept of reflection, which is a type of transformation that moves each point on a plane or geometric shape using the properties of objects and shadows on a flat mirror [13]
	Mathematics (Concept of Folding Symmetry)	The batik pattern has the concept of folding symmetry where folding symmetry is the number of folds that can be formed by a plane into 2 equal parts [14].
	Mathematics (Concept of Square and Rectangular Flat Buildings)	In the picture some of the woven products have square and rectangular shapes. A square is a rectangular flat shape that has four sides of equal length. Whereas a rectangle (English: rectangle) is a two-dimensional flat shape formed by two pairs of sides, each of which is equal in length and parallel to its partner, and has four angles, all of which are right angles [15].

	Mathematics (Concept of Tessellation)	The weaving pattern in the collection uses the principle of teselasi. It uses one type of geometric figure, the rectangle. Notice that there is no distance between the shapes. Tesrelation is a special pattern consisting of geometric figures arranged without separation/distance to cover a flat area. Another term that is often used to refer to theses is tiling [16].
	Mathematics (The concept of a pentagon)	A pentagon is a shape that has 5 sides that are equal in length and has 5 angles that are equal in size. A pentagon is also known as a pentagon. There are 5 sides of a pentagon with each side having the same length.
	Mathematics (Concept of Curved Side Spaces, Spheres)	In the object collection, the pottery has a shape like a ball. The ball is one of the curved side spaces composed of an infinite number of circles centered at one point, namely the center point of the ball. The ball can also be interpreted as the set of all points in three dimensions that are equidistant

		from a reference point, namely the center point of the ball.
	Mathematics (Concept of Flat Sided Spaces, Triangular Prisms)	In the collection of objects in the form of a wagon, the roof is shaped like a triangular prism. A triangular prism is a three-dimensional shape consisting of two triangular bases and three rectangular sides. This triangular prism is a pentahedron or object with five planes.
	Mathematics (Concept of parallel lines in traditional musical instruments)	In the musical instrument, it can be seen that it is parallel to each other with a rectangular shape so it is called a parallel building. Parallel lines are two lines that do not intersect but have the same slope so they are parallel to each other [17].
 Puppet Collection	Mathematics (Dilatation Concept)	In the collection of puppet objects, it can be seen that there are puppets that are large to the smallest. This is why the puppet collection is included in the concept of dilation. Dilation is the reduction or enlargement of an object with a certain scale. In dilation, the location and size of

 Musical Instrument Collection		an object changes, in contrast to transformations in reflection, rotation, and translation which only change the position of the object [18].
	Mathematics (Translation Concept)	Translation is the shifting of all points of an object along a straight line on a geometric plane with the same distance and direction. The result of the transformation is congruent with the original object. Translational geometry is widely applied to batik motifs with alternating models [19].
	Mathematics (Reflection Concept)	In the mask there is a transfer of objects using mirroring, namely a flat mirror so as to produce the same shadow. So that the mask is included in the concept of reflection, which is a type of transformation that moves each point on a plane or geometric shape using the properties of objects and shadows on a flat mirror [20].

 Batik	Mathematics (Concept of Rotation in basic batik patterns and rhombuses)	Rotation is the movement of a point to another point by rotating the point against an angle, a certain center point, and has the same distance to each rotated point. The concept of rotation is widely applied to batik motifs and also batik media [21].
	Mathematics (Concept of Curved Line)	In the kris collection, there is the concept of curved lines. A curved line is a name for a curved line that connects at least 2 points in different positions. The curved line is also commonly known as a curved curve.
	Physics (Concept of Spring Force)	In a catapult, this spring force will produce potential energy and energy of motion. The energy possessed by a moving object is called kinetic energy. So, the catapult used works on the principle of spring force that produces mechanical energy, which comes from the combination of potential energy and kinetic energy.
	Physics (Concept of Elasticity, Hooke's Law)	Hooke's law is a law that explains the force in physics that occurs due to the

		elasticity of an object or spring, so when playing catapults. On the rubber part of the catapult used to aim at the target or target
	Physics (Concept of Parabolic Motion)	When a catapult containing stones or pebbles is pulled and then released, the stones or pebbles will be ejected with a trajectory that forms a parabola. Parabolic motion is a combination of Regular Straight Motion (RSM) in the horizontal direction (horizontal) with Regularly Changing Straight Motion (RCSM) in the vertical direction.
 Gamelan musical instruments	Physics (Concept of Sound Waves)	Based on this classification, gamelan instruments are classified according to their sound sources, namely ideophones, membranophones, aerophones and chordophones. Ideophones are gamelan instruments whose sound source comes from the instrument itself, such as the kenong. Membranophones are gamelan instruments whose sound is pro-

		duced by the vibration of the skin membrane due to being hit, for example, drums. Aerophones are gamelan instruments whose source of sound is blown air, such as flutes. Chordophone is a gamelan instrument whose sound source is produced by the vibration of plucked or rubbed strings, such as zither [22].
	Physics (Principle of Circular Motion)	When spinning on the ground, the principle of Regular Circular Motion applies. Circular motion or also called circular motion is the movement of an object that forms a trajectory in the form of a circle with one axis or fixed point in the center. A movement can rotate, because there is a force that can deflect it towards the center or axis of the circular trajectory, this force is called centripetal force (Fs). The circular motion that applies is Regularly Changing Circular Motion (RCCM), because the rotation of the top is gradually getting stationary or stopping [23].

	Physics (Moment of Inertia)	The case will still maintain its rotational state, so it is called the moment of inertia. Moment of inertia is the tendency of an object to maintain its rotational state of motion. The farther the position of the mass of the object to the center of rotation, the greater the moment of inertia of the object [23].
	Physics (Concept of Energy Change)	The change in energy in the concept of the spinning top game is seen when the spinning top starts spinning and gradually stops. This is a change in kinetic energy. $\Delta E_k = \frac{1}{2} m (v_2 - v_1)$ [23].
	Physics (Frictional force)	The friction force also affects when the top is in the position when it is thrown, namely the friction between the top rope and the top so that it will cause the top to move [23].
Bamboo Collection	Biology (Concept of Biodiversity, Species level)	In the bamboo collection at Sonobudoyo Museum, there are several types of bamboo that show biodiversity. Examples are spotted bamboo (*Bambusa maculata*

	 Spotted Bamboo *(Bambusa maculata widjaja)*  Ampel Bamboo *(Bambusa vulgaris Schrader ex Wendland)*  Ori Bamboo (*Bambusa bambos (L.) Voss)*		*widjaja*), ampel bamboo (*Bambusa vulgaris Schrader ex Wendland*), and ori bamboo (*Bambusa bambos (L.) Voss*). The three types of bamboo are species in the genus Bambusa, which shows species-level biodiversity.
Hardwood Flora Collection		Biology (Concept of Plant Morphology (stem morphology))	The collection of flora that has hard

Teak Wood

Coconut Wood

Jaranan Wood

Midi Wood

wood in the Sonobudoyo Museum is an example of the nature of the stem in plant morphology. Flora such as teak, coconut, jaranan, midi and others in the Sonobudoyo Museum are plant species whose stems have woody stem properties (lignosus). woody stems are composed of lignin tissue so that the tree trunk is hard and strong.

 Teak Wood	Biology (Concept of taproot system)	Many types of flora collections at Sonobudoyo Museum are taprooted plants. Flora such as Teak and Sukun are plants that have fibrous roots in their root system.
 Sukun Wood		
 Bamboo	Biology (Concept of Filamentous Root System)	Some types of flora in the collection at Sonobudoyo Museum are plants with a fibrous root root system. Flora such as bamboo and coconut trees are examples of collections that have fibrous roots.
 Coconut wood		

 Bamboo	Biology (Concept of Monocotyledonous Plants)	Some of the flora collections at Sonobudoyo Museum such as bamboo, areca nut and coconut belong to the monocotyledon group of the angiosperms subdivision (closed seed plants) which have unbranched stems.
 Coconut wood		
 Areca tree wood		
 Jaranan Wod	Biology (Concept of Dicotyledonous Plants)	Some of the flora collections at Sonobudoyo Museum such as teak, jaranan, mindi, kemuning, breadfruit, mahogany, jackfruit and pule are dicotyledonous plants because they have two-parted seeds.

Midi Wood

Teak Wood

Sukun Wood

Kemuning Wood

Mahogany Wood

Jackfruit Wood

Pule Wood

Bekisar Chicken
(Gallus varius x Gallus domesticus)

	Biology (Concept of Crossover)	One of the biological collections at Sonobudoyo Museum is the bekisar chicken offset. Bekisar chicken is the result of a cross between a male jungle chicken and a female native chicken.
	Biology Taxonomy Concepts, Mammal Class)	In the biology collection at Sonobudoyo Museum, there is a hedgehog offset. Hedgehogs

Offset Hedgehog *(Hystricomorph Hystricidae.)*		are animals that belong to the mammal class of the Chordata phylum.
Fauna of the Aves Class  Ofset Ayam Kampung *(Gallus domestica.)*  Ofset Ayam Bekisar *(Gallus varius x Gallus domesticus)*  Ofset Burung Merpati *(Columba lavia)*	Biology (Taxonomy Concepts, Aves Class)	Some of the biological collections at Sonobudoyo Museum are aves class fauna. Fauna such as native chickens, bekisar chickens, pigeons, kutilang birds are fauna that belong to the aves class of the Chordata phylum.

Ofset Burung Kutilang *(Pycnonotus aurigaster)*

Fauna of Reptile Class

Sawa Kembang Snake Offset *(Phyton reticulates)*

Cobra Snake Offset *(Naja sputatrix)*

Water monitor lizard offset (*Varanus salvator*)

Turtle Offset *(ordo Testudinata subordo Cryptodira dan Pleurodira)*

Biology (Taxonomy Concepts, Reptile Class)

Some types of fauna that are collections at Sonobudoyo Museum are fauna of the reptile class. The reptile class fauna collection includes a set of sawa kembang snakes, cobras, water monitor lizards, and turtles.

 Human skeleton chest	Biology (Concept of the Movement System)	The collection of fossils and skeletons in the Sonobudoyo Museum is one example of the movement system. The skeleton is a passive means of motion in the human body, because it is only a place for muscles to attach. The motion system is a system that can produce movement consisting of bones and muscles and is assisted by joints of bones as passive means of motion because they cannot move by themselves and muscles as active means of motion because they can contract and relax.
 Nayan Gold Mask	Chemistry (Elemental Concept)	Some objects in the Sonobudoyo Yogyakarta Museum collection are made of gold, iron, silver, bronze and others. Therefore, these collection objects are types of metal element objects. In this element, the material is very shiny and able to be a good conductor of electricity and heat. For metals will generally be solid at normal pressure and temperature unless using
 Genta Kalasan		

		mercury. Basically, metals are very easy to forge, which makes it easy to make various objects. Types of metal elements such as aluminum (Al), iron (Fe), Gold (Au), Barium (Ba), Calcium (Ca), Potassium (K), Chromium (Cr), Nickel (N), Sodium (Na), Manganese (Mn) and Magnesium (Mg).
	Chemistry (Concept of Corrosion)	Some of the collection objects from Sonobudoyo Yogyakrta Museum are made of iron. This can lead to corrosion (rusting). Basically, corrosion is the release of electrons from a metal (iron or steel) in an electrolyte solution such as sea water. The main cause of iron corrosion is the presence of oxygen in air and water. Iron will not rust in dry air or in water that is free of oxygen. So, both oxygen and water are important compounds in corrosion [24].
	Chemistry (Concept of Redox Reaction)	Iron rusting is a redox reaction. Iron rusting is the result of unwanted redox reactions (reduction

		and oxidation). In the rusting process, iron (Fe) acts as a reducer and oxygen (O2) dissolved in water acts as an oxidizer. The reaction equation for rust formation is divided into two, namely the anode (oxidation) and cathode (reduction). Anode: Fe → Fe2+ + 2e– (E° = -0,45 V) Cathode: O2 + 4H+ + 4e– → 2H2O (E° = 1,23 V)
 Batik	Chemistry (Concept of Compound)	Compounds are single substances that can be broken down into two or more simple substances by chemical means. The batik collection at Sonobudoyo Museum is made of chemicals and coloring agents. The chemicals used in the batik making process include: caustic soda (NaOH), soda ash (Na2CO3), baking soda (NaHCO3), sulfuric acid (H2SO4), sulfite, and nitrite While the dyes used include: acid dyes, basic dyes, rec dyes, reactive dyes, naphthol dyes, and vessel dyes. In addition, the

	components of the mordant (color locking) substance used in the fixation process in the manufacture of batik cloth use several chemical elements, including: alum (KAl (SO4)2), arbor (Fe (SO4)), pijer/borax, lime water (Ca (OH)2), calcium carbonate (CaCO3), calcium hydroxide (Ca (OH)2), citric acid (C6H8O7), copper (II) sulfate (Cu2 (CH3COO)4), iron sulfate (FeSO4. 7H2O), and potassium dichromate (K2Cr2O7) [25].

The table 1 shows that there are a lot of ethnomatscience concepts in the Sonobudoyo Yogyakarta Museum, so it can be utilized as a medium for learning culture-based mathematics and science in schools in the form of textbooks and other learning media. In the table found mathematical and science practices. Mathematical practices in the form of geometric shapes, namely flat planes and mathematical concepts which include geometry concepts (translation and reflection), symmetry concepts (folding symmetry), curved side spaces, and circular flat planes and many more. Then for science practices in the form of Physics (Spring Force, Hooke's Law, Parabolic Motion, Friction Force, and others), Biology (Monocotyledonous Plants, Dicotyledonous Plants, Crosses, Taxonomy and others), and Chemistry (Corrosion, Redox Reactions, Metal Elements, and Compounds). Learning that incorporates ethnomatscience sourced from Sonobudoyo Museum Yogyakarta will add students' insights into the existence of math and science in one of their cultural elements, increase motivation in learning and facilitate students in linking the concepts learned with real-world situations. Thus, learning math and science becomes more meaningful, fun, and able to increase student motivation in learning math and natural science and can instil local wisdom values to students [26]. Students become more proud and able to interpret the nation's cultural values with the science they have.

4 Conclusion

Based on the discussion that has been presented above, it can be concluded that the concept of ethnomatsains contained in the Sonobudoyo Museum Yogyakarta can be used as learning mathematics and science in schools in the form of learning media and textbooks. Thus learning math and science becomes more innovative, meaningful and can also increase motivation in learning. Learning that inserts ethnomatsains sourced from the Sonobudoyo Yogyakarta Museum will add students' insights into the existence of mathematics and science in one of the cultural elements they have, increase motivation in learning and facilitate students in linking the concepts learned with real-world situations. In addition, it can teach and introduce local wisdom values to students. Students become more understanding, recognize and proud of the nation's cultural values with the addition of the lessons they have learned.

Acknowledgments. Thanks to the Ministry of Education and Culture and Alma Ata University for funding and guiding this research through the Student Creativity Program. This research article is funded by the Institute for Research and Community Service, Universitas Alma Ata.

References

1. Manoy, J. T., & Purbaningrum, M. Mathematical Literacy Based on Ethnomathematics of Batik Sidoarjo. Jurnal Didaktik Matematika, Vol 8(2), 2021, pp. 160–174.
2. Fuadi, H., Robbia, A. Z., Jamaluddin, J., & Jufri, A. W. Analisis faktor penyebab rendahnya kemampuan literasi sains peserta didik. Jurnal Ilmiah Profesi Pendidikan, Vol 5(2), 2020, pp. 108-116.
3. Abdullah, A. A. Etnomatematika; Eksplorasi Transformasi Geometri Pada Ragam Hias Cagar Budaya Khas Yogyakarta. Jurnal I lmiah Soulmath: Jurnal Edukasi Pendidikan Matematika, Vol 8(2), 2020, pp. 131.
4. Richardo. R. et al. (2020). Learning mathematics through Islam Nusantara culture: An etnomathematics study in Indonesia. Ethnomathematics Journal, 2020, Vol 7(1), pp. 30–35.
5. Atmojo, S. E. Pengembangan Perangkat Pembelajaran Ipa Terpadu Berpendekatan Etnosains. Jurnal Pendidikan Sains (JPS), 2018, Vol 6(1), pp. 5-13.
6. Richardo, R. Pembelajaran Matematika Melalui Konteks Islam Nusantara: Sebuah Kajian Etnomatematika di Indonesia. Jurnal Pendidikan Matematika, 2020, Vol 3(1), pp. 86-98. DOI: https://doi.org/http://dx.doi.org/10.21043/jpm.v2i2.6360
7. Bakhrodin, Istiqomah, U., & Abdullah, A. A. Identifikasi Etnomatematika Pada Masjid Mataram Kotagede Yogyakarta. Soulmath; Jurnal Ilmiah Edukasi Matematika, 2019, Vol 7(2), pp. 113-124.
8. Soelistijanto, R. Pemahaman Dan Kemampuan Peserta Didik Menjawab Pertanyaan Evaluasi Pelajaran Sejarah Soal Esai Siswa Kelas XI Di SMA YPE Semarang. Pawiyatan (Edisi Khusus Dies Natalis). 2013, Vol 20(3)
9. Juano, A., & Jediut, M. eksplorasi etnomatematika dan hubungannya dengan konsep geometri pada matematika sekolah dasar dalam budaya masyarakat Manggarai. Jurnal Pendidikan Dan Kebudayaan Missio, 2019, Vol 11(2), pp. 270-278.

10. Abdullah, A. A., & Rahmawati, A. Y. Eksplorasi etnomatematika pada batik kayu krebet Bantul. UNION: Jurnal Pendidikan Matematika, 2021, Vol 9(2), pp. 163-172.
11. Hariyani, S., Ningsih, N., & Fayeldi, T. Analisis Kesalahan Siswa dalam Menyelesaikan Soal Lingkaran Berdasarkan Kategori Watson. UNION: Jurnal Ilmiah Pendidikan Matematika, 2019, Vol 7(2), pp. 187-200.
12. Pertiwi, I. J., & Budiarto, M. T. Eksplorasi etnomatematika pada gerabah mlaten. Jurnal Cendekia: Jurnal Pendidikan Matematika, 2020, Vol 4(2), pp. 438-453.
13. Oktaviani, T., & Sholihah, D. A. Eksplorasi Etnomatematika Pada Budaya Banyumasan Sebagai Sumber Belajar Matematika. LITERASI (Jurnal Ilmu Pendidikan), 2022, Vol 13(2), pp. 100-117.
14. Jainuddin, J., Silalong, E. S., & Syamsuddin, A. Eksplorasi Etnomatematika pada Ukiran Toraja. Delta-Pi: Jurnal Matematika dan Pendidikan Matematika, 2020, Vol 9(2).
15. Rahayu, K., & Putra, N. Etnomatematika di Balik Kerajinan Anyaman Bali. Denpasar: Universitas Mahasaraswati Denpasar, 2014.
16. Charitas, R., Prahmana, I., & Ambrosio, U. D. Learning Geometry And Values From Patterns : Ethnomathematics On The Batik Patterns Of Yogyakarta , Indonesia. Journal on Mathematics Education, 2020, Vol 11(3), pp. 439–456.
17. Marina, M., & Izzati, N. Eksplorasi etnomatematika pada corak alat musik kesenian marawis sebagai sumber belajar matematika. Jurnal Gantang, 2019, Vol 4(1), pp. 39-48.
18. Sholihah, S. A., Dewi, I. S., & Mariana, N. Eksplorasi konsep matematika pada batik jetis sidoarjo untuk mentransformasikan konteks pembelajaran matematika di sekolah dasar. EduHumaniora| Jurnal Pendidikan Dasar Kampus Cibiru, 2021, Vol 13(1), pp. 76-85.
19. Nisa, R. Eksplorasi Etnomatematika pada Batik Pamiluto Gresik. Briliant: Jurnal Riset Dan Konseptual. 2020, Vol 5(3), pp. 442-448.
20. Samijo, S., & Yohanie, D. D. Pengaruh model pembelajaran kontekstual berbasis etnomatematika pada pola batik tenun (ATBM) khas Kota Kediri terhadap kemampuan refleksi dan simetri mahasiswa semester 2 Prodi Pendidikan Matematika UNP Kediri. Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika, 2017, Vol 3(2), pp. 135-145.
21. Astuti, E. P., Purwoko, R. Y., & Sintiya, M. W. Bentuk etnomatematika pada Batik Adipurwo dalam pembelajaran pola bilangan. Journal of Mathematics Science and Education, 2019, Vol 1(2), pp. 1-16.
22. Prasetya, H. B. Fisika Bunyi Gamelan: Laras, Tuning, dan Spektrum. Yogyakarta: Badan Penerbitan ISI Yogyakarta, 2011.
23. Astuti, I. A. D., & Bhakti, Y. B. Analisis Konsep Fisika pada Permainan Tradisional Gasing sebagai Bahan Ajar Fisika. Navigation Physics: Journal of Physics Education, 2021, Vol3(2), pp. 74-79.
24. Putri, A. F., & Fitriyanti, D. Kegiatan preservasi di Museum Benteng Vredeburg Yogyakarta sebagai salah satu upaya pelestarian pengetahuan masa lampau. Al-Kuttab: Jurnal Kajian Perpustakaan, Informasi dan Kearsipan, 2022, Vol 4(1), pp.79-90.
25. Indrayani, L. Pengolahan limbah cair industri batik sebagai salah satu percontohan IPAL batik di Yogyakarta. Ecotrophic, 2018, Vol 12(2), pp. 173-185.
26. Shanti, W. N., Sholihah, D. A., & Abdullah, A. A. Meningkatkan kemampuan berpikir kritis melalui ctl. Jurnal Pembelajaran Matematika, 2018, Vol 5(1), pp. 98-110.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.