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Realistic mathematics education: Building mathematical conceptions in sasak culture

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Abstrak: In the context of cultural anthropology, people have known various mathematical activities, such as counting, measuring, and weighting, which have different terms based on each culture. We understand that mathematics emerges from people activities in responding to the existence of their environment. Sasak people conduct various cultural activities in their daily life. One of which is in agriculture and in the form of traditional arts, therefore, this study aims to build mathematical conceptions by exploring the activities of Sasak culture that can be integrated into mathematics learning contextually. This study was an ethnographic research Data were collected through field study, interviews with Mr. Lalu Agus Fathurrahman as a Sasak's artist, Mr. Raden Gedarip as a Sasak's humanist, Lalu Anggawa Nuraksi as a Sasak's humanist, Amaq Riajim as a traditional farmer, and Amaq Darsih as a traditional farmer. Comprehensive information was obtained from them on how Sasak people use mathematics concepts in agricultural activities and traditional forms of art. Research results indicated that the culture of Sasak people relevant with principles and characteristics of Realistic Mathematics Education (RME) is a learning approach that can be integrated, both explicitly and implicitly.

Keywords: Realistic Mathematics Education; Mathematical Conceptions; Culture

Pendidikan Matematika Realistik: Membangun Konsepsi Matematika dalam Budaya Sasak

Abstak: Pada konteks antropologi budaya, masyarakat telah mengenal berbagai aktivitas matematika seperti membilang, menghitung, mengukur dan menimbang, dengan istilah yang berbeda dari masing-masing budaya. Kita pahami bahwa matematika muncul dari aktivitas masyarakat dalam merespon keberadaan lingkungan mereka. Masyarakat suku Sasak melakukan berbagai aktivitas budaya dalam kesehariannya. Diantaranya adalah pada aktivitas pertanian dan bentuk kesenian tradisional oleh karena itu tujuan dari penelitian ini adalah membangun konsepsi matematika melalui eksplorasi bentuk aktivitas budaya Sasak yang dapat diintegrasikan ke dalam pembelajaran matematika secara kontekstual. Penelitian ini merupakan kajian etnografi. Data dikumpulkan melalui studi lapangan, wawancara dengan bapak Lalu Agus Fathurrahman seorang Seniman Sasak, Bapak Raden Gedarip seorang budayawan Sasak, Lalu Anggawa Nuraksi seorang budayawan Sasak, Amaq Riajim petani tradisional dan Amaq Darsih petani tradisional. Dari mereka didapatkan informasi secara komprehensif bagaimana masyarakat suku Sasak menggunakan konsep matematika dalam aktivitas pertanian dan bentuk kesenian tradisional. Hasil penelitian ini menunjukkan bahwa relevansi budaya masyarakat suku Sasak dengan prinsip dan karakteristik pendidikan matematika realistik (RME) sebagai pendekatan pembelajaran yang dapat diintegrasikan baik secara eksplisit maupun implisit

Kata kunci: Pendidikan Matematika Realistik; Konsep Matematika; Budaya

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INTRODUCTION

Mathematics emerge from diverse human activities developed in various ways and techniques in responding to the environment, which aim to find explanation, understanding, experience, and solution towards encountered problems or phenomena (D'Ambrusio & Rosa, 2016; Morgan, 2018). Mathematics is the science of quantity, structure, space and change. Mathematics has developed historically, through abstraction and logical reasoning, to the activity of calculating, measuring, and studying the shape and motion of physical objects (Yadav, 2020). On the other side, the followers of social constructivism perceive mathematics as a social construction. Mathematics has a very important role in human civilization, where mathematics is one way to solve various problems that occur naturally in a group of humans (Jayanthi, 2019). Mathematics is influenced by many social activities, histories, and environments where human life grows, thus, mathematics is not culture-free (D'Ambrusio & Rosa, 2016). However, in facts, mathematics is being taught as a inflexible formal routine, as a result, students do not use mathematical knowledge they acquire from the environment.

Realistic Mathematics Education (RME) is perceived as having the characteristics that can contribute to the integration of culture into mathematics learning. The main characteristics of realistic mathematics education (RME) include the implementation of meaningful contexts, the model development that transforms contextual mathematics into formal mathematics, the implementation of mathematics conceptualizations by students, the interactive interaction between students and teachers, and the capability to generate mathematical perceptions as the learning subject that is integrated with the real life (Clements & Sarama, 2013). Such characteristics are the parts of the process to connect, identify, and solve mathematics problems by interpreting mathematical solutions based on the context. Basically, characteristics of realistic mathematics education (RME) is the part of progressive mathematics processes (Laurens et al., 2018). Culture-based mathematics learning in the real life is the pedagogical innovation in mathematics learning aimed for students to love mathematics, get motivated and improve their creativities in learning mathematics (Prahmana et al., 2021). In that order, realistic mathematics education (RME) is a learning motivation rooted in the real life by connecting mathematical ideas growth in people, therefore, students can learn mathematics easily.

The involvement and inspiration of students are depending on how success teachers design the learning environment. The main notion in brain-based learning is the meaningful learning, where the new knowledge acquired in formal forms can be integrated into the previous knowledge found in the environment (Gözüyeşil & Dikici, 2014). This is also the core of realistic mathematics education. Teachers who apply realistic mathematics approaches for planning have to focus on the framework of new mathematics knowledge with cultural understanding. This can be done with many innovative ways by using mathematics histories, community mathematics, or inviting students to use their cultural perception to perform mathematization. The context in realistic mathematics education is to support the reinvention process that provides the opportunity to perform mathematics progressively, so students can understand mathematics formally through the mathematics interpretation process found

naturally in the environment (Lisnani et al., 2020). Thus, students can build and develop literacy skills from experiences found in their environment.

According to the purpose of mathematics learning at school, the content standards in mathematics learning contain aspects in mathematical literacy skills (Anisah et al., 2011; Ari Damayanti et al., 2017). Mathematical literacy skills are one's skills in formulating, implementing, and interpreting mathematics in various contexts, including mathematical reasoning, using concepts, procedures, facts and instruments of mathematics to illustrate, while explain and predict phenomena that occur in their environment (OECD, 2016). A similar argument was also proposed by Hera & Sari (2015) that mathematical literacy skills work as one's capability to formulate and interpret mathematics in various contexts of the daily life efficiently. Mathematical literacy skills become one of the main competences in doing daily activities, which are implemented in the learning purpose of mathematics at school (Heriyadi & Prahmana, 2020).

Mathematical interpretations in the real life have high meaning and relevance with the empowerment of life, based on the local culture and reality encountered sociologically. If reviewed further, culture can be understood as a pattern of meanings, established historically and transmitted socially, embodied in symbols and languages, where humans communicate, preserve, and develop their knowledge and comprehension regarding life (Emmer, 2015). Mathematics has to be understood as a cultural product that is built based on practices that produce language, belief, religion, ritual, food-producing technique, artefact, and others. Therefore, we can say that every culture produces mathematics (Emmer, 2015). In that order, cultural accommodation in mathematics learning is required. To accommodate a change in mathematics learning, an effort that needs to be done is developing a pedagogic theory based on realistic mathematics education (REM) in the critical paradigm through an explicit relationship between student's culture and school learning material.

Sasak people in Lombok Island – West Nusa Tenggara – Indonesia, still adhere to the customs throughout generations, this can be made as the development of realistic mathematics education (RME) based on local culture. Sasak people have local culture systems that live and grow that fulfill the seven universal cultural elements, which consist of language system, knowledge system, kinship system, life equipment system, economic system, religious system, and art system. Therefore, the embodiment of these systems of local culture can be extracted to find mathematical ideas that grow and be integrated into mathematics learning formally. In mathematics learning, the development of assessment in the form of affective can provide mathematical disposition for students to be able to think and act positively in mathematics, in which this condition is consistent with the meaning contained in cultural education and nation's characters (Sumarmo, 2011).

Several researchers have explored and explored various uniqueness in the culture of the Sasak people (Fauzi et al., 2021; Fauzi, Hanum, et al., 2022; Fauzi, Hayati, et al., 2022; Fauzi & Gazali, 2022; Kusaeri & Pardi, 2019; Supiyati et al., 2019; Sutarto, et al., 2021). Fauzi, et al (2021) explore mathematics in the layout of the traditional *Segenter* village. Resumed by Fauzi, Hanum, et al (2022) explores mathematical ideas and educational values in the

traditional residential architecture of the Sasak people. Fauzi, Hayati, et al (2022) exploration of mathematics and cultural values in *perisean* performing arts. Fauzi dan Gazali (2022) ethnomathematical studies on residential characters based on *sikut awak*. Khusairi dan Pardi (2019) identify mathematical objects contained in the cultural products of the Kembang Kerang community in East Lombok and their implementation in Islamic educational institutions. Supiyati (2019) examines ethnomathematics in the architecture of the Sasak tribe's traditional house. Berikutnya Sutarto et al (2021) exploration of the transformation of the weaving geometry of the Sasak Sukarara tribe.

Building knowledge by involving student's culture and daily experience as the basic knowledge make mathematics learning to be more meaningful (Bonotto, 2017). Besides the actual use of student's experience, teaching or learning environment is also designed based on student's culture and be implemented in mathematics learning activities through new socio-mathematics norms (Bonotto, 2017). Teaching mathematics through cultural relevance and personal experiences helps students to know more about reality, culture, people, and themselves (Barton, 2017). In its turn, this effort will help them to be more aware, critical, appreciative, and confidence. This condition will help them build new perspectives and syntheses, find new alternatives, and support them to change some existing structures and relationships. This study aims to provide a description of how mathematical ideas in culture can develop a sustainable mathematics education and can be made as the learning source while become the instrument that can create new dialects between school mathematics and real life.

METHOD

The method used in the study was an ethnographic method. Ethnographic method is culture-describing activities, which are aimed to understand the way of life of others from a different perspective (Spradley, 2016). The selection of this ethnographic method is consistent with ethnomathematics' purpose, namely studying ideas, methods, and techniques in a specific culture from the perspective of the cultural members (Ascher & D'Ambrosio, 2012). Data were collected through field study, interviews with Mr. Lalu Agus Fathurrahman as a Sasak's artist, Mr. Raden Gedarip as a Sasak's humanist, Lalu Anggawa Nuraksi as a Sasak's humanist, Amaq Riajim as a traditional farmer, and Amaq Darsih as a traditional farmer. Comprehensive information was obtained from them on how Sasak people use mathematics concepts in agricultural activities and traditional forms of art.

Ethnographic studies always imply cultural theories because each community always uses a meaning system to manage their behavior, understand themselves, and understand the world they live in (Spradley, 2016). This method is consistent with the studies of realistic mathematics education (RME) that are focused on the involvement of student's culture and daily experience as the basic knowledge in learning mathematics (Bonotto, 2017). This thing is consistent with the aim of the study, namely exploring mathematical ideas contextually in Sasak culture activities, especially in farming activities and forms of Sasak people's traditional art. The collected data were analyzed through content analysis and taxonomy analysis to

discover ideas and meanings as well as mathematical ideas found in agricultural activities and forms of Sasak people's traditional art.

In this study, we took locations in three districts that have traditional villages, namely Sade Village, Central Lombok Regency, Segenter Village, North Lombok Regency and Limbungan Village, East Lombok Regency, considering that these three locations have different languages and customs as well as the character of the people. The results of data collection were analyzed using triangulation techniques to comprehensively explore ideas and meanings as well as mathematical ideas found in agricultural activities and in traditional art forms of the Sasak people.

RESULT AND DISCUSSION

Culture involves mutual understanding in which individuals can interact or communicate to each other (Stenhouse, 1997). This definition emphasizes the role of communication in culture, which has a specific meaning in education. In this meaning, cultural constructs work as a whole umbrella in which all human communicative activities can be interpreted. Culture is also perceived as dynamic behaviors and in a state of constant transformations. This transformative cultural view underlines the importance of negotiating social norms at class. Individuals change or understand their culture through the interaction with environment based on mutual experiences (Barta et al., 2003). Culture is also applicable at macro, meso, and micro levels of educational environments, which encompass society, school, and class. Teaching and learning actions exist in culture, which are varied from one society to another, from school to school, and even from class to class. Therefore, culture defines the types of ongoing learning and highly affects the types of experience in which students get involved in. This condition is consistent with the studies of mathematics education that attempt to analyze the correlation between mathematics education and cultural values in the daily life (Bishop et al., 2011). The way to integrate the education of cultural values into mathematics education at school can be done through an actual approach, in which teachers use mathematics as the instrument in instilling values during the teaching, and by discussing the values shown in the daily life (Tapsir, 2017). In practice, more activities containing student's cultural values should be built more (Chin & Lin, 2001).

The initial point of the natural process for every mathematical sociology is that every culture has their respective conception of number. Daily human creations or behaviors are manifested in the form of ideas, activities, or artefacts, these what we used to call as cultural manifestation. Values contained in the form of human behaviors show aesthetical skill and creative power of humans, while the integration between mathematics and culture is contained in the daily activity in contextual and realistic forms.

Diverse cultural products that became the ancestor's heritage show mathematical activities in the daily life, such as in agriculture, trading, carpentry, even in livestock. Without being realized by our ancestors, mathematical activities have been performed through these activities. Kline (1990) explains that mathematics is a creative activity to answer questions or

problems that emerge directly from social interactions. This condition also happens to Sasak people, namely:

1. Agricultural Sector

The primary function of land for Sasak people is as the source of livelihood and life. The land use pattern for productive activities can be in forms of *bangket* (paddy field), *kebon* (farm), and *rau* (field). In specific times, Sasak people who work as farmers spend more of their time in paddy fields by building a simple house as their living place, which is referred to as *berepok*.

Generally, Lombok Island has a high rainfall, so there are two seasons which according to Sasak people's terms are referred to as *musim taun* (rainy season) and *musim balit* (dry season). Sasak people plant paddy during the *musim taun* (rainy season). The planted paddy is new or old varieties of paddy, namely *pade jamaq* (*Bulu* paddy). While during the *musim balit* (dry season), Sasak people plant *palawija* (CGPRT crops). The ownership of paddy fields is based on the tradition of Sasak people, which consists of two terms, namely owner farmer (*mekel*) and cultivator (*penyakap*).

The initial phase of land processing is *ngampar* (sowing rice seeds). After approximately a month of seeding process, seeds are ready to be pulled out (*ngmbot ampar*) and be tied by using ropes made from young *enau* leaves. Terms in rice seed ties used by Sasak people are *mêmên* (a tie of seed in the size of two adult handfuls), *kancê* (two seed ties/*due memen ampar*) and *pongos* (ten ties of seed/*sepulu memen ampar*). The measurement of the number of seeds that will be planted is depending on the area of paddy field, with the calculation as follows.

1 are requires *sepongos ampar* (10 *memen*/ties)
10 are require 10 x *sepongos ampar* (100 memen/ties)
100 are (1 hectare) require 100 x *sepongos ampar*

Table 1. The number of seeds that will be planted based on the area

Area (are)	Number of Seeds (ties)	Information
1	10 *memen (sepongos)*	1 *memen* (in the size of a handful of adults)
10	10 *pongos*	
100	100 *pongos*	

The number of seeds that will be planted by farmers is calculated based on the area to be planted with a ratio of 1:10 or 1/10. The matter above can also be applied to an algebra material, namely one-variable linear equation.

After six months, paddies are harvest (*mataq*) together with the closest family. The paddy harvesting tool (tie cutter) is called as *rangkapan*. Harvested paddies are tied by using young *enau* leaves. Terms for the ties are *awin* (a tie in the size of a handful of adults), *rêrêk* (two ties size two handfuls of adults*/dwe awin*), *cekel* (three *rêrêk*) and *daut* (twenty *cekel*). The details are shown by the following table.

Table 2.The size of the ties of harvested paddy

Type of paddy ties	Size (ties)	Size (kg)
Awin	a tie in the size of a handful of adults	1-1.25
Rêrêk	2 *awin*	2-2.5
Cekel	3 *rêrêk*	6-7.5
Daut	20 *cekel*	120-150

The distribution of yields is based on the ownership type. If the owner cultivates the land himself, the yields will be distributed to the owner and *pekasih* in which the *pekasih* is given with a 10% share. If the paddy field is cultivated by others (*penyakap*), the yields will be divided among three people, namely owner (*mekel*), cultivator (*penyakap*), and *pekasih* (the farm manager) with the following conditions.

Table 3. The Distribution of farming yields

Type of Ownership	Crop Yield	Season	
		Taun	*Balit*
In Kg			
Mekel	100	90 kg	50 kg
Penyakap		9 kg	50 kg
Pekasih		1 kg	
In paddy ties			
Mekel	100	90 *cekel*	50 *cekel*
Penyakap		9 *cekel*	50 *cekel*
Pekasih		1 *cekel*	

Mathematical activities in the agricultural sector give a lot of descriptions of how mathematical models are used, for instance, in the distribution of crop yields, the preparation of seeds, and others. Therefore, the mathematical form used is a direct proportion math.

The proportion between *a* and *b* is always equivalent, which means that if the *a* value increases, the *b* value will also increase, so does if the *a* value decreases, the *b* value will also decrease.

$$a: b = c: d \; or \; \frac{a}{b} = \frac{c}{d}$$

Crop yields during the *taun* season are distributed to the owner, *penyakap*, and *pekasih* with a ratio of 1: 9 : 90 = 1/100, 9/100 and 90/100, while during the *balit* season, the crop yields are only divided among the owner and *penyakap* through an equal distribution, i.e., 1 : 2 = ½

Geleng (barn) is the place to store the crop yields, such as rice and CGPRT crops. The size of *geleng* depends on the social level of the local people. *Geleng* is a non-residential building that works as the supportive building, consisting of four round pillars, and an upper storage for crop yields, which is equal in height, length, and width.

Figure 1. The shape of *geleng*

Figure 2. The storage for rice and CGPRT crops inside *geleng*

The form and structure of *geleng* describe many mathematical models that can be made as the part of contextual learning, especially in the geometric learning.

Indonesia with its uniqueness and diverse traditions in each region provides an opportunity for researchers to explore mathematical studies realistically from various perspectives, such as Exploration of mathematics in the culture of the Mbojo community as a source of learning mathematics. (Sutarto, Ahyansyah, et al., 2021), Geometry exploration of the flat shape of the State Museum of South Sumatra Balaputera Dewa (Lisnani et al., 2020), Mathematical exploration through ethnomathematical studies at Borobudur Temple (Utami et al., 2020), Ethnomathematical exploration on pottery forms Mlaten (Pertiwi & Budiarto, 2020), Ethnomathematical studies on the Soko Tunggal Mosque and its implementation in 2D Geometry Learning (Putra et al., 2020), ethnomate study Ethnomathematical study of Umbrella Craftsmen Geulis Tasikmalaya West Java (Muslim & Prabawati, 2020). These various studies illustrate that mathematics is inseparable from our activities as humans and our culture, thus it is important for teachers to understand the character, habits and culture of students as part of the initial steps in learning mathematics in the classroom.

2. Sasak traditional art

Every region has a form of art with special character and cultural pattern that becomes the identity of the region. Therefore, local arts are the peaks of culture available in regions and become the symbol of the owner. Sasak traditional arts are diverse, either from its dances, music, and handcrafts. If seen from the existence, some Sasak traditional arts are still being preserved, including *gendang belek* and *perisean*. The shows started with rituals in an aim to acquire safety during the shows. The conducted rituals include finding a good day to begin the show by asking for the help from Adat stakeholders. Their calculation used the modulo concept as in the calculation used in Sasak's calendar or *wariga*.

Gendang Beleq is an orchestra that consists of two large drums named *gendang mama* (male drum) and *gendang nina* (female drum), which work as the dynamic carrier. A *gendang kodeq* (small drum), and two *reog* as a melodic carrier. Each *reog mama* consists of two tones and a *reog nina*, a *perembak beleq* that works as a rhythmical instrument, and eight pieces of *perembak kodeq*. These *perembak* are at least six pieces and at most ten. A *petuk* as a rhythmical instrument, a large gong as a rhythmical instrument, a jerking gong as a rhythmical instrument, a gong *oncer* as a rhythmical instrument, and two red or yellow flags called *lelontek*. *Gendang beleq* is played where royal parties are held, it works as a war cry to encourage soldiers. *Gendang beleq* can be played while walking or sitting. The time composition for the walking position has specific rules, different with the sitting position that has no specific rules.

Figure 3. Gendang belek traditional art

This martial art has been existing since the kingdom era in Lombok. In the beginning, this art is a kind of sword and shield practice conducted before taking off to the battlefield. In its development, the weapon that is used until present is a piece of rattan layered with asphalt, and tempered glass shards called *penyalin*, while shield (*ende*) is made from cow or ox hides. Each player or *pepadu* is equipped with a headband (*sapuk*) and a long fabric. This art is inseparable from the ritual ceremony and music that evoke the spirit to war. *Gambelan*

is the instrument used in the background music that consists of a gong, a pair of *kekepek* (drum), a *rincik* or cymbal, a flute, and a *kanjar*. The match will be stopped if one of the *pepadu* bleeds or stopped by the jury. Every *pepadu* upholds sportsmanship, so there is no grudge between them outside the area despite the fight is quite rough and often caused bleeding injuries inside the arena.

Figure 4. *Perisean* traditional art

The musical instruments and costumes used in Sasak traditional art are in geometric shapes. Geometric shapes exist in the musical instruments of *gendang belek* and *perisean* are tubular drum, flute, and *penyalin*; circular *perembak*; *gong* and *petuk* in the shape of beheaded cone, and rectangular *ende*. The clothes have patterns or *reragian* as in Sasak's term, use geometric shapes, such as two-dimensional figure, shapes of animal and plant.

CONCLUSION

The form of contextual cultural education that involves social cognition of children on what they have experienced, is quite simple, because when children learn from others and their environment, they may be able to understand the people and the environment as the integral component of the basis of learning processes. Although, there is a possibility that cultural learning experiences depend directly on the individual integration concept of all experience exists in their mind.

According to the research results, it can be concluded that there is a relevance of Sasak people's culture with principles and characteristics of realistic mathematics education (RME) as a learning approach. Local culture values can be integrated with realistic mathematics education (RME), both explicitly and implicitly. Explicitly, cultural integration can be designed in learning plans and the development of learning materials. While implicitly, local culture can be integrated into educational values, such as tolerance, agreement, consistence, logical, rational, and systematic. The transformation of local culture into realistic mathematics education (RME) contributes to the development of literacy skills, mathematics conceptions,

and student's character, therefore, students are expected to learn and fathom mathematics concepts conveniently.

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