Study of Ethnomathematics : A lesson from the Baduy Culture

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Abstract. This article examines ethnomathematics of Baduy community which are devoted to the elements of their technology and underlying great value. Although none of the Baduy people who attend formally school because their custom prohibit it, however, their way of thinking and their life values are very interesting to study, especially in their anti-rat technology based on mathematics and theoretical physics are logically and correct.

Keywords: Baduy, ethnomatematics

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Introduction

This article discusses ethnomathematics of the Baduy community or indigenous Sundanese at Leuwidamar, the District of Lebak, Province of Banten. Sometimes it refers to "Bedouin", the name given by people outside Baduy. The Baduy name allegedly come from the term Dutch researchers who compare them with Badawi or Bedouin in Arabic tribes which are nomadic society. But, they prefer to call themselves as "urang Kanekes" according to the name of their territory, or sometimes they also refers to the name of their village as "urang Cibeo" (Garna:1993)

The uniqueness of the Baduy community than other communities is that of their custom which prohibits formally school, so that none of the Baduy citizens educated in both the primary and secondary levels. Because they do not recognize   the formally   school, then almost all Baduy citizens are not able to read and write. Only very small citizens who can read and write, that is because they have much interaction and communication with other people outside Baduy.

Although formally school is not welcome in Baduy because their custom prohibits it, but it does not mean that Baduy people have no anything knowledge at all. The knowledge in their point of view is that of it can help someone to survive in harsh terrain of baduy, especially in their field of life which is not sufficient to conquer it by only reading and writing the theory in the classroom. Therefore, they choose to learn from nature behavior directly without staying for a long time like us to study the theory how nature works properly in a class. Their mindset and their great values are also very interesting to study. They prove to us , although the dynamics of life goes up very rapidly and when globalization create boundaries between countries and cultures increasingly narrow,but they still can exist until now by showing their own heritages that are believed from

the generation to next generation without being affected by foreign cultures. Those things have attracted the passion of some researchers to explore the indigenous culture of Baduy. In the future hope, the education, especially in Indonesia that is having multi-culture and multi-ethnique, also has distinctive features than before in which the local wisdom used as a starting point in learning. Why the local wisdom is very important in our education? Because learning the subject from our local wisdom is not only to enrich and to make the instruction more fruitful, but also to keep and to continue the underlying values of it.

Etnography, Ethnomathematics and Mathematical Modelling

Ethnography is a description and analysis of a social groups based on the field research as the data. Ethnography represent the data that is essential for all research in cultural anthropology. Therefore, for a comparative study or a comparison of community samples from around the world, it takes ethnographic data about each samples to study (Pinasti: 2007).

There are seven ethnographic framework which are ingredients of studying the cultural unity of ethnic groups in a community as follows: (1) language, (2) technology, (3)economic system, (4) social organization, (5) knowledge , (6) art, and(7) religious system. Due to those elements are universal and we can identified every social groups, ethnique and nations using those frameworks, therefore all human activities can be classified into one of them (Pinasti:2007)

Ethnomathematics, according to NASGEM, North American Study Group Of Ethnomathematics, broadly defined that ethnomathematics study is not limited to small-scale groups, but the prefix "ethno" can refer to any group such as nation, labor unions, religious traditions,, and so on. It including the use of mathematical symbols, spatial design, methods of calculation, measurement in space and time, specific ways of reasoning, and other human activities that can be translated into a formal mathematical representation are also in this field of study.

Etnomodeling is the study of mathematical ideas of different social groups. Generally, These ideas come from their daily activities which can be related to seven ethnographic frameworks above. Ethnomodeling involves a mathematical formula that are developed and used in everyday life by members of the community group. (Rosa and Orey: 2013).

Furthermore, Barton (1996) asserts that ethnomathematics is a field of study which examines the way from other cultures understand, articulate and use concepts and practices which are from their culture and which the researchers describes as mathematical.

Those opinions above implies that when we study of ethnomathematics, it does not mean we only study mathematical phenomenon and translated it into a formal mathematical concepts (mathematical modeling). But, more than that, the way of thinking and the underlying values why a particular individual or group can have such an understanding like that is also interesting to learn.

In other word, Study of ethnomathematics is essentialy consists of studying cultural anthropology(ethnography), mathematical modeling and mathematics itself. The intersection of those components of mathematics, mathematical modeling and ethnography called ethnomathematics. This relationship can be depicted as follow
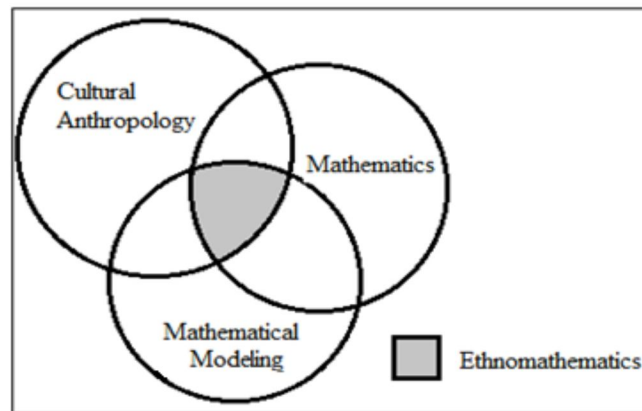
Figure 1. Ethnomathematics (taken from Rosa & Orey:2013)

Why Ethnomathematics is Important in Mathematics Learning

As quoted from Ezeife, A.N. (2002) :

Approaching the teaching and learning of mathematics from a cultural standpoint serves a two-pronged purpose: It tends to build a bridge between the student's background knowledge, and the formal mathematics teaching and learning the student would encounter over several years in a typical school setting

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There are two main missions in education, the transfer of value and transfer of knowledge. These are the main aspects that must be considered by educators in teaching and learning activities. Teachers do not merely transfer the knowledge, but also must be able to transfer the values of the local wisdom in the students neighborhood. Unfortunately, not all the instruction in the classrom uses the local wisdom as the starting point in learning activities. That's why a lot of students do not know anything about their culture again. This conditions make education today has been torn apart from its existence as an integrated part of the culture (Tilaar:1999)

This problem causes the education is not in the right direction again due to the students lack of awareness to demonstrate their identity. The values of cultural nation is a local wisdom that it should be upheld to be characteristic of the national education. If it is not the spirit again in education, then surely the noble values will be lost.

Ki Hajar Dewantoro a former of minister of education in Indonesia said that "culture can not be separated from education, even the culture is base or basic for education". This statements reaches far into the future, because education is not merely based on one aspect of culture such as the intellectual aspect, but the culture as a whole. (Tilaar, 1999: 68).

Various approaches which are related to the real life have been developed by experts to improve both the level of students' cognitive and affective so that students can absorb and understand the concepts being studied. These approaches also make students love mathematics more. In essence, both ethnomathematics and other similar approaches such as Contextual Teaching and learning /(CTL) or Realistic Mathematics Education (RME) are actually trying to "reconcile" mathematics that is often associated with abstract objects into the realm so that   it can

be applicable for students to solve encountered problem in everyday life. The National Research Council (1989) as quoted in Ezeife, A.N. (2002) stated:

Public attitudes about mathematics are shaped primarily by adults' childhood school experiences.Consequently, mathematics is seen not as something that people actually use, but as a best forgotten (and often painful) requirement of school. For most members of the public, their lasting memories of school mathematics are unpleasant – since so often the last mathematics course they took convinced them to take no more .

The use of real events in their daily activities for students will make learning of math ematics more meaningful and fruitful. The use of it as a starting point in learning can be associated with one of the cultural elements above. For example if the majority of students are Javanese or Sundanese , the teacher should teach the values of Javanese or Sundanese culture in learning in order they do not forget their identity.

The model implementation of culture based learning on students to be important today because learning in primary and secondary schools must emphasize on the establishment of a positive character that reflects the cultural values of the nation besides improving the cognitive aspects of students. Various models and approaches in learning should be directed positively in shaping the personality of students. So hopefully, in the future these students will keep and remember the noble values of their own culture even though they are studying abroad..

Ethnomathematics in Baduy Community

This article will discuss ethnomathematics at the Baduy community which is devoted to the anti-rat technology commonly referred to geuleubeug on leuit legs. Leuit is a room for Baduy people to keep their harvest unatended for a long time. Because Baduy's houses made of combustible materials, Leuit built separately from their house to avoid something bad happened like a fire. Technology to repel rats that usually eat the harvest handled without killing them. It is Because Baduy people are very concerned with protecting the environment and nature. They have a rule that nature should not be changed but should be what it is. Killing rats largely is equal to destroy the nature because the ecosystem and the food chain will be disrupted. Although they have no formally school, but, the way they think, especially in making anti-rat technology are really interesting to study.

Figure 2. Geuleubeug
(Taken from Arisetyawan et.al:2014)

Generally, Leuits of Baduy, based on measurements are 1.5 x 1.5m to 2x2m. The height of its leg between 1 and 1.5m. However, not all Baduy people using geuleubeug on leuit legs, it only used by inland baduy. Therefore, in addition to repel the rat, they also use the leaves which is stucked into their leuit such as, *teureup, mara , kakandelan, cariang, rane , and tumbu esi* (Permana,CE:2012).

Figure 3. Leuit with Geuleubeug
(Taken from Arisetyawan et.al:2014)

Based on information we get from Musung, a citizen from Gajeboh, outland Baduy, the wooden circle or geuleubeug on the legs of leuit make the rats difficult to climb it. This is due to the position of the rat body will change when going up from a vertical position   to a horizontal position when going through the wooden circle. Because the wooden circle is quite slippery, so when the rat body is in horizontal position , its legs are not strong enough to keep staying in geuleubeug. Thus, the Earth's gravity will make the rat body attracted to bottom when trying to crawl horizontally. The following explanation of why the rat is difficult to climb into leuit can be explained using mathematical concepts as follows, see the vector forces acting upon the rat moves vertically
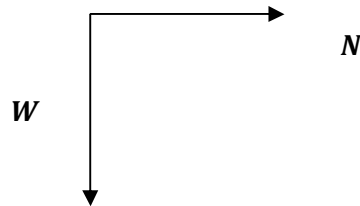

Figure 4. the vector forces acting upon vertical position
(Taken from Arisetyawan et.al:2014)

On the diagram of vector above, *N* denotes the contact force or normal forca between the legs of leuit and the rat body, while *W* denotes the vector of the rat's weight which is downward direction. Either *N* or *W* are perpendicular each other which means physically that the two vectors are independent. Meanwhile, when we compared the vertical position above with the current horizontal position below, both of them are coincides precisely with each other
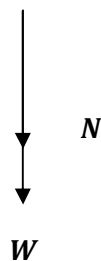

Figure 5. The vector forces acting upon horizontal position
(Taken from Arisetyawan et.al:2014)

At the time the rat body is in the horizontal position, the contact or normal force between the body of rat with a wooden circle is perpendicular to the contact surface or the legs of leuit, so that the normal force *N* coincide with the weight vector *W*. Therefore, its efforts in climbing the legs from vertical to horizontal positions clearly not the same. When the rat is in the vertical position, the only force to be encountered is its own weight , while the rat is in the horizontal position, there are two forces must be encountered, those are normal force *N* and *W*

In a condition where geuleubeug is made quite slippery, so it is increasingly difficult to the rat to climb. It is known that the wheel can rotate or human can walk on the earth surface because there is a friction. If there is no friction force, the wheels of the car and human will not rotate and walk well. therefore, in a case between the rat and the legs of leuit above, to make geuleubeug is quite slippery, then the coefficient of friction will be smaller. Mathematical relationship between the force of friction, coefficient of friction and the normal force can be written as follows:

$$\boldsymbol{f_s} = \mu_s \, \boldsymbol{N}$$

In which $\boldsymbol{f_s}$ is the friction force , μ_s is coefficient of friction and $\boldsymbol{N}$ is normal force or cantact force.

From the mathematical relationship above, it seems that the value of the friction coefficient is proportional to the friction force and it is inversely proportional to the normal force N, this means that the greater coefficient of friction, the smaller the value of normal force and vice versa. Based on algebra vector, when the rat is in a horizontal position, then the total force becomes

$$\boldsymbol{W_{total}} = \boldsymbol{W} + \boldsymbol{N}$$
$$= \boldsymbol{W} + \frac{\boldsymbol{f_s}}{\mu_s}$$

If the surface of the wooden circle is made very slippery and the coefficient of friction is zero, then mathematically, the total force will be infinite so that it causes the rats may not be able to pass geuleubeug.

The noble values of Baduy

Although none of Baduy people get formally school and sometimes people outside Baduy labeled them as "stupid person" because they refuse the ease of technology such as electricity, phone,car and television, however, their principles of life are great and deserve to emulated. No matter what happened and future bring from the outside world , they will cling with their principle of life and their own culture. This is a great lesson to us as "modern man" who sometimes forget and overestimate that western culture are greater than others. It is very important today to show that we must be proud to uphold our own culture as integrated part of our identity. Who will keep continuing our own culture if the next generation do not know anything and never be proud about their own culture.

The other noble values to be learned from the Baduy is the value of honesty and solidarity. They are people who keep the honest as the spirit of life. Eventhough their harvests saved in leuit and far away from their house and no one who keep them everyday , but no citizen there dare to be a thief because their life is not based on money and wealth. Like Musung said that if someone from Baduy lie, than based on their belief, this person will get karma soon.

If we link it to education, where the values of honesty and solidarity began to fade, we can see that many plagiarism blowing up today, no matter it is done by academician or student. Why this can be happened, because in heterogeneus people, especially in seeking the job or popularity after finishing the school, all need to show their ability to be number one. This makes the value of solidarity no more exist if someone think that anyone is the rival.

Another positive things if it is associated with the learning of mathematics in schools, especially primary schools, all approaches that are based to the culture activities and daily life is an approach having characteristics of maintaining local wisdom and also strengthening the life skill. Why life skill is important for student because the knowledge they learn must support their life. For example, all of lesson learned by baduy people directly come from the natural surroundings. How do they learn to survive in the harsh terrain of Baduy even educated people will not survive if they live in baduy for a long time are very interesting case to study. In the harsh terrain of baduy, life skill is more important than learning theory in a class. That's one reason why Baduy people reject to attend a formally school. everything associated with their knowledge must be real and applicable in their daily life.

Conclusion

several important points can be drawn from the results above are that of Baduy knowledge is interconnected with nature and their surroundings. although none of Baduy people get formally school, but since their knowledge based on the realm, thus their life skill about how to survive in this life much better   than someone who only study the nature theoretically in the class. We believe that sometimes theory is not the same with real fact, so that if we link it into mathematics instruction in a classroom, we need concrete subject in mathematics to make student interest and to make student understand what real problem can be soved by mathematics. The more little relevance of mathematics subject to the real life, the more connection is not established by students. That's why local wisdom is important today, as quoted from Jacob (1992) in Ezeife, A.N.(2002)

The wisdom of our elders must be recognized and respected. To the extent possible, traditional knowledge should be documented and codified. Regional centres of traditional knowledge should be established in native communities and supported by all sectors.

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