Indigenous science: what we can learn? (the exploration of balinese local wisdom for science learning)

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Abstract. Indigenous science is the original knowledge of local communities in studying natural phenomena based on observations produce product, attitudes, and scientific in processes in accordance with the culture and location of the community. The research purpose is to explore indigenous science based on balinese local wisdom that can be used in science learning at school. This research is an exploratory study. Data collection use observation, interview, and literature study. Data analysis was also carried out for data on indigenous people’s knowledge and local wisdom. Based on the result of data analysis, there are three dimensions of science in the balinese local wisdom that can be used in science learning: first, local wisdom contains element of scientific attitude; second, local wisdom is a scientific product; and the third finding in this study is local wisdom as a scientific process.

1. Introduction
Science is human intellectual heritage, where humans are aware of their environment, asking about natural phenomena to start searching for the secrets of nature to change their perspective but also changing the way he solves the problems of daily life and science education is the process of developing scientific knowledge, science process skills and scientific attitudes among individuals [1]. Science aims to change the lives of people in the world in a faster way. Helping people to live a better life and on the other hand, in still new ways of thinking and new approaches to solving their problems. Learning science at school aims to develop the ability to provide clear explanations of natural phenomena, knowledge, and understanding of scientific inquiry and interpret and evaluate data based on evidence to make valid conclusions [2].

One source of learning in science learning is to use local wisdom in which there is a genuine knowledge of the community called indigenous science. Indigenous science is a knowledge system owned by indigenous peoples to observe, collect, categorize, record, use, disseminate and revise information and concepts that explain how the world works, this knowledge system is used for their
daily lives [3]. Indigenous science is a part of social construct in society which has and still believed to be true [4]. Indigenous science as ethnoscience means knowledge that is owned by a particular tribe or ethnic group in a nation [5]. Ethnoscience deals with local perceptions, practices, skills, and ideas in studying the structure of the universe as a basis for socio-economic development [6]. Indigenous science contains elements of philosophy, techniques, and applications that are used by the community to understand natural phenomena that are passed down from generation to generation.

The application of learning based on local wisdom is a form of the contextual learning approach. Local wisdom is a part of local culture that can be understood as a human effort by using knowledge to act and behave in response to something, objects, or events that occur in a particular space [7]. Learning models based on local wisdom by reconstructing indigenous science can improve student character in terms of conservation. Learning material based on problem-based learning by integrating local wisdom can help students improve critical thinking skills even on a small scale [8]. Using mobile phone-based character assessment instruments with local wisdom had fulfilled the valid and reliable requirements so it was suitable for measuring the character of the school’s cultures and the character of the junior high school students with quick and accurate calculation results [9]. Local wisdom based learning modules on Natural Sciences subjects can improve student science literacy skills [10]. Based on the description above shows that local wisdom can be used as a source of science learning. The purpose of this study is to explore the local wisdom of Balinese people which contains indigenous science that can be used in science learning in schools.

2. Methods
This research is an exploratory study is scientific research conducted in the filed with the aim of obtaining more knowledge an in-depth description and an explanation of an event or phenomenon that occurs. Data collection techniques in this study use: observation, interview and literature study. Observation is used to observe Balinese community activities based on local wisdom. Interviews are used to explore information about the meaning of Balinese community activities based on local wisdom. Study literature to find information about indigenous science based on local wisdom. The data analysis technique used is descriptive qualitative. To validate the accuracy of the results of the study used triangulation techniques.

3. Results and Discussion
From the study of data analysis of local wisdom of the Balinese, there are several forms of indigenous science that can be used as studies in science learning.

3.1. Local wisdom contains element of scientific attitude.
This scientific attitude can be seen in the concept of Tri Pramana and Tri Kaya Parisudha. Tri Pramana is a way of learning whose elements consist of: 1) energy (Baya) that is to do learning that uses energy, such as practicing, experimenting, observing; 2) the ability of voice or language (Sabda) to carry out information-based learning, for example listening to information from teachers, reading books; and 3) the ability of mind (Idep) that is to do learning using the mind, for example analyzing natural phenomena, doing problem-solving, applying knowledge, concepts, principles that have been studied in other situations [11]. Tri Kaya Parisudha comes from the vein of ‘Tri’ means three, Kaya means deeds, and Parisudha means holy/good/right. Therefore, Tri Kaya Parisudha is three deeds that must be sanctified by good thinking good (Manacika), good speaking (Wacika), and good behaving (Kayika) [12].

Both concepts above can be applied in learning science because it trains students to have a scientific attitude which is a combination of thinking skills, ability to work (psychomotor) and the ability to communicate like scientists. Scientific attitude is a mental attitude characterized by a desire to seek the truth and prejudice of one's opinion based on new evidence and to look for cause and effect and relationships to distinguish between facts and theories [13]. Practicing scientific attitudes must be carried out continuously, starting from the primary school level. Better science process skills are
obtained by using ethnoscienc strategies, teachers must utilize information and involve learners actively in the teaching and learning process through the use of an adequate ethnocentric paradigm [14].

3.2. Local wisdom is a scientific product
The scientific product produced by the Balinese people is the implementation of original knowledge which is done by natural experiments, even testing it with nature itself.

| Table 1. Scientific products in the local wisdom of Balinese people |
|---------------------------------------------------------------|
| **Local Wisdom** | **Indigenous Science** | **Modern Science** |
| The roof of the house, *meru* and *pelinggih* from tile, palm fiber and grass (*ilalang*) | The use of roofs from tile, palm fiber (*ijuk*) and grass (*ilalang*) makes the temperature conditions in the house not too hot during the summer. This is because Bali has two seasons, heat and rain so that all building materials are from nature. | Tile is made of soil, palm fiber is part of the palm tree (*Arengaapinnata*) and grass (*ImperatacylindricaRaeusch*) is a poor conductor of heat. So, modern science is the application of the concept of isolator and conductor. |
| Using *kerikan kedebong* (banana stalks) to treat wounds and attach young banana leaves to the forehead to reduce heat in sick children | Bananas are plants that are believed to inhibit the release of blood and young leaves are used to reduce heat by sticking to the forehead. | The application of the concept of temperature and heat release, because bananas contain low temperatures and the human body is so high that blood stops coming out and body heat is absorbed by banana leaves. |
| Installation of building poles for houses not planted but using *sendi*(support). | The use of *sendi* (support) on the construction of Balinese houses, to reduce the effects of tremors due to earthquakes. The ancestors have realized that Bali is an earthquake-prone area. | The application of the concept of forces and types of forces, in this case is friction. |
| Making traditional ingredients (*base gede*) and *boreh* (scrubs) using *lesung* (mortar) and *alu* (pestle) | The mortar used is made of stone and pestle made of wood which is used to smooth the spices and *boreh* by pounding it with the direction up and down | Application of the concept of capillarity. |
| Lights in puppet shows | The lights used in *wayang* (puppet) shows consist of coconut oil and cotton thread which is placed in a place called *blencong*. Coconut oil-fueled lamps provide long lighting, because the puppet show lasts 1 to 2 hours. Balinese people know coconut oil as a natural fuel. | Conservation and environmental preservation. |
| The ritual of *tumpek warige* | *Tumpek Wariga* is the day of the *Sanghyang Sangkara* descent that keeps the salvation of all plants (trees). | |
| The use of coconut (fruit, leaves) and bamboo as a complementary ceremony | Coconut and bamboo are elements that are needed in carrying out Hindu rituals. Bamboo and coconut are used because they are easy to find in Bali. Bamboo is a strong plant and has a light weight. | |
Scream “idup, idup” when an earthquake occurs. The function of screaming during an earthquake, to tell neighbors to leave the house immediately.

Use urine when pierced with sea urchins. The northern Balinese fishing community, when pricked in sea urchins, the first treatment that can be done is to give urine. Urine contains ammonia acid which can chemically break down toxins.

When the rain is accompanied by lightning, the Balinese people will throw the sickles into the field. Throwing sickles into the ground when the rain is accompanied by lightning, is believed to be able to avoid lightning strikes. Because what will be struck is the discarded sickle.

Kertamasa in growing rice. Kertamasa is the process of growing rice simultaneously and cannot plant crops other than rice. The goal is to avoid pest attacks, if anyone violates it will be subject to sanctions.

| Activity                  | Scientific Process                                           |
|---------------------------|--------------------------------------------------------------|
| Pauman (meeting) subak members to plan to plant rice which is usually done on sasihkapat until kalima (September to November) or before planting begins. The ritual of mendak toya and ngendag memacul is begun. Mendak toya as a symbol of fetching water in water sources as a source of life so that rice plants can thrive without drought and ngendag memacul is a ceremony to start hoeing the fields by hoeing three times the 'upstream rice' diversion symbolically accompanied by a spell (discourse ritual) spoken by the farmer and addressed to Dewi Sri. The implementation of the Kertamasa rule at the time of planting rice begins. Kertamasa is a form of regulation for simultaneously planting rice issued by the secretary of Subak (penyarikan). | Identify and express a problem. Pauman, mendak toya and ngendag memacul is a form of identifying problems, namely checking the condition of the water source whether it is sufficient or not, checking the condition of the soil whether it is ready to be planted.

The rice planting process starts from the nursery stage or is called ngurit until the process of planting the seedlings is determined based on good days (padewasaan) and nandur (rice planting activities). Formulating Hypotheses. Kertamasa is a traditional form of hypothesis, if planting rice is not simultaneously, it is feared that there will be continuous growth and pest attacks. So kertamasa is the process of controlling pest growth.

Design and carry out an experiment.

Science is understanding natural phenomena based on observation activities. Indigenous science is a form of observation by local people in studying nature and its symptoms for survival. The integration of indigenous science in science teaching at school prevents science from becoming an exclusive lesson which is understood only by a group of people, and it will become true science for a daily living, science for the future and science for all [7]. Using local wisdom as a learning resource can increase student motivation because it is contextual, so students learn with real problems and solve problems with traditional ways of thinking based on local wisdom and compared with modern science.

3.3. Local wisdom as a scientific process

The scientific process can be seen in a Balinese agricultural water management system called Subak.

Table 2. Scientific Processes in Traditional Agricultural Systems in Bali
When the rice has been planted in the field, activities are carried out: 1) majukut (the process of cleaning weeds); 2) ngenyatin (the process of drying the rice field once, aims to strengthen rice roots); 3) carrying out various rituals during the process of rice growth namely: mayusa (this series of agricultural rituals is carried out in accordance with the age of rice plants, namely 12 days, 17 days, 27 days, 35 days, 24 days and 70 days), byakukung (rituals for rice plants that start craving or ceremonies when the plants begin to contain) and mabahin (rice begins to bear fruit). The purpose of this activity is to see the process of rice growth.

The mepuah activity (banishes the birds when the rice is already fruiting) by attaching ambat (rope) and using a kapuakan (made of bamboo) tool that gives a loud sound to scare the birds. And the farmers doing this surveillance activity are carried out in a small hut called rangon. This activity is carried out from the morning until evening and stops at the time of harvest.

Harvesting activities (manyi). Before harvesting the mecaru ritual must be carried out under sanggah penanduran which is a series of ritual offerings to creatures such as Sedahan Be Julit and Sedahan Yuyu (crab), Juru Tumbuk and Sedahan Padi which aim to ask for safety and not be disturbed during rice harvestin.

The Ngerasakin ritual 'paying taxes' in the rice fields is the last ceremony after the harvest ends. Paying taxes in the context of this ritual is in the form of an offering (pengrasak) to God, especially its manifestation, Dewi Sri. This ceremony is an expression of gratitude to farmers for the Lord for the harvest that was successful by means of the chicken, duck, or pork that was rolled. The symbolic meaning of this ritual is the form of devotion to God, especially Dewi Sri and Dewi Uma and their followers for all His gifts because they have obtained good harvests.

4. Conclusion

Indigenous science is the original knowledge of local communities in study natural phenomena based on observations that produce products, attitudes, and scientific processes following the culture and...
location of the community. In the Balinese local wisdom, there are three elements of science: scientific attitudes, scientific products, and scientific processes. So, local wisdom can be used as a learning resource for science by integrating into learning. Integrating local wisdom in learning, providing meaningful learning. Meaning is meant by students learning by the context of the students being and understanding (competency to be achieved).

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