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Balinese Local Wisdom and Their Implications in Science Education at School

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Abstract

This study was aimed to dig Balinese local wisdom, to reconstruct, and develop them in the teaching process at school. Local wisdom are parts of local culture which can be understood as a human effort by using their cognitions to act and behave as the response to something, object, or an event that occurs in a particular space. The method used in this study is a meta-analysis of empirical studies done by the researcher since 2005 in Bali. Eastern communities (Balinese - Indonesian in particular) have a worldview which is very different from that of the eastern communities (Euro-American) being the places where the culture of sciences was born. The students who live in the eastern cultural environment will find it difficult to learn science at the school since the indigenous culture does not receive enough attention and is different from what they learn in science. Therefore, in the process of science teaching at the school, Balinese local wisdom need to be used as learning resources in the context of science teaching. One model of teaching that is suitable for overcoming this problem is by applying local culture-based teaching model. This model uses the collateral learning theory in its implementation. If the student's culture matches the science lesson, mutual strengthening will occur, but if it differs then they will be developed together in parallel without alienating

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1. Introduction

Low quality of education in Indonesia still receives attention from many people. One of them is less development of value education in science at school (Adimassana, 2000; Suastra, 2012). This is seen from various problems that are faced by Indonesia. For example, damages in natural environment caused by natural disasters, drug abuse that is getting more serious among the people from children to adult people and hoaxes and slanders that spread in social media,

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terrorism, and the stir because of separatist issues recently. All the problems only produce and leave miseries of Indonesians themselves. Zamroni (2000:1) states that education tends to become an instrument of "social stratification" and the school system only "transfers" to the students what is called dead knowledge, that is, knowledge which is too focused on books (textbookish), so that it is as if it has been separated from its source and application. Furthermore, Suastra (2005; 2008) states that values uplifted by Balinese community that is full of local genius are ignored in the teaching, especially in science teaching at the school. Thus, science teaching becomes "dry" and less meaningful for the students. It is this that needs to be given a serious attention from the policymakers and local science education practitioners.

National education which is based on Pancasila and the 1945 Constitution function to develop abilities and to form the nation character with dignity in the effort to educate Indonesians. To serve this function, the government runs a national educational system as specified in Act of the Republic of Indonesia No. 20 of 2003 on National Education System. The implementation of the act is explained in a number of regulations, like Government Regulation No. 19 of 2005 on National Education Standard. The legal instruments communicate that a curriculum should be developed by a school to enable the adjustment of education to the needs and potentials of the local regions. It is this opportunity that has to be made use of by the decision makers in education in the local region and science teachers in Bali in an effort to develop local potentials and at the same time to preserve values of wisdom contained in Indonesia's culture.

Future science teaching needs to be made in such a way that there is a balance/ harmony between scientific knowledge and scientific attitude development, and values of local wisdom that are existing needs to be given a serious attention in developing science education at the school since in it contained indigenous science that can be useful for life. Thus, science education will become truly useful for students and the public. This is in line with today's science education reform perspective which stresses the importance of science education in the effort to enhance social responsibility (Suastra, 2015).

Based on this reformation effort, the aim of science education is not only to enhance understanding of the science itself, but the more important one is how to understand human life itself. How human creates understanding about the world (worldview) and how they interact with all macro cosmos systems are much determined by their worldview and universal values (Baker,1995).

Based on this problem the problems that will be studied in this article are:1) differences between Balinese worldview and Western worldview, 2) cultural aspects in science, 3) difficulties faced by Eastern culture in learning science. and 3) stages in science teaching based on local culture and the role of the teacher in its implementation.

2. Materials and Methods

This study uses a meta-analysis of the empirical studies done by the writer himself since 2005 up to 2015. The empirical studies refer to Suastra (2005); Suastra et al (2010); Suastra, (2015). Suastra (2005) through a qualitative study to dig and reconstruct indigenous science (Balinese local wisdom) that are existing in the traditional village of Penglipuran as the source of learning resources in science education process at school. In 2010, Suastra, et al. Studied a local culture based science teaching with local wisdom content as learning resources in science teaching at the junior secondary school. Suastra (2015) studied the effectiveness of local culture teaching model to develop science basic competence and local wisdom in Bali.

3. Results and Discussions

Based on the problems stated in the introduction, the results and discussion are presented as follows.

3.1 The Differences of Traditional Balinese World View and Western World View and their Implications for Science Education

Barnhardt (2003) states that to learn a culture means to learn a lifelong. Thus, a cross-cultural science teacher has to learn more about other's culture. The more we can learn the other's culture, including their world view, the more we will find ourselves. Following is some views about the universe both from the Western community and the traditional community (non-western).

Table 1
Differences in worldview between Balinese traditional community and Western
Community world view

Balinese traditional Community world view	Western community word view
Spirituality exists in the cosmos elements (*bhuwana agung* (macro cosmos/the universe) and *buana alit* (microcosmos /human itself)	Spirituality is centered around God
Human is responsible to maintain the harmony in its relationship with nature (*Tri Hita Karana*)	Human forces its dominance over nature for its personal welfare and to improve its economic level
Resources are seen as a gift (before eating a meal it is offered first to God for the meal is the gift, to fell trees for making a house is done with ethics. Asking a permission from the Creator and the feeling is in accordance to the needs only.	Natural resources are available to be exploited by a human that follows one-way direction
Nature is respected periodically by doing spiritual practices every day (upacara *Tumpek Ngatag* ritual (plants), *Tumpek Kandang* (domestic animals), *Mecaru* (the earth and its environment	Spiritual practice is rarely done and is separated daily life
Wisdom and ethics come from direct experiences with nature (*piteket*/ guidance from parents/ancestors)	Human thinks in facing nature and this can produce free insights
The universe consists of dynamic natural forces which keep on changing. The universe is seen as consisting of a holistic, integrative system with unifying living forces	The universe is divided into two and is conceptually reduced to conceptually smaller parts l
Time is circular with natural circles (*cakra sang kala*) which support the life	Time follows a linear chronology of "human progress"
Nature is always mysterious and there is something hidden behind it	Nature can fully be understood by a rational human thought
The human mind, feeling, and words are in a subtle way related to all other aspects of the universe	The human mind, feeling, and words are formed separately from the surroundings.
Human's role is to participate in the natural design in a regular way.	Human's role is to cut, analyze and manipulate nature for its own self
Respect to parents is based on love and reconciliation from knowledge directed from outside.	Respect for others is based on material achievement and chronological age
Seeing a good relationship of a human with nature as a two-way transactional dialog based on ethics/ values	Seeing human relationship with nature as something hierarchical and one direction

Source: Adapted from Knudson dan Suzuki, 1992; Suastra, 2011.

Differences in cultural perspectives as described above have implications in all aspects of daily life and also in science teaching at the school. Therefore, teachers or educators in the non-western communities including Balinese community have to pay attention to the differences in order the learning objectives can be achieved effectively. This is in line with what is stated by Barnhardt (2003) that cultural system is very influential to human behavior in general.

3.2 Cultural Aspects in Science Teaching

To learn about the process of science teaching at the school, in addition to understanding the process from the psychological perspective that is based on personal constructivism from psychological theory and sociological perspective that is based on social constructivism, researchers and education scholars now are trying to use anthropological perspective. The latter tries to see science teaching at school from the cultural setting of the

surrounding culture (Suastra, 2005b; Cobern and Aikenhead, 1996). According to anthropological perspective, science teaching is assumed to be a cultural transmission and science teaching as a cultural acquisition. In such a way, science teaching in the classroom can be likened to the process of transferring and acquiring a culture from the teacher. The meaning of culture here is a system of symbols and meanings that are applicable to the social interaction of a community (Geertz, 1973). Based on this definition, science can be taken as a sub-culture of western culture. Thus, indigenous science (local culture) from a community in the non-Western village is a subculture from the subculture in the non-Western nations is the subculture of the community culture itself.

The effect of western science is very strong in science in the school whose purpose is to transmit cultures from the dominant countries. The subcultural transmission of science can help and can destroy or separate. If the science subculture, in general, is harmonious with the students' daily culture, the science teaching will tend to strengthen the students' view of the tendency of the universe, and the result is to use enculturation (Hawkins and Pea, 1987). If enculturation occurs, students'scientific thinking about daily life will increase. However, if the science subculture is different from the students' daily culture, like what is the case for many students (Costa, 1995; Ogawa, 2002), then, science teaching will have a tendency to destroy or separate the students' view of nature so that they will leave or put aside their indigenous method. The result is assimilation (Jegede & Aikenhead, 2000) with a negative connotation as the evidence of the presence of "educational hegemony" or "cultural imperialism" (Battiste in Cobern & Aikenhead, 1996:5). The students will struggle to negotiate to penetrate the boundary between the indigenous subculture and science subculture. However, in reality, the students often refuse the important aspects of their own culture. As an example, in a series of studies from 1972 to 1980 in Papua New Guinea, a significant effect on the separation of the students from their traditional culture was found. In the more formal schools, the students tend to accept allineation. For Balinese case, this can be seen from the increasingly more damage of nature such as the damage of protected forest, reclamation of beaches in the interest of hotel development, the damage of reefs, the increasingly less forest, and the increasingly more loss of rare animals in Bali (*burung jalak* Bali, green turtles, *kokokan* birds). There is a need to know Indonesian science educators' views of science in science new perspective. For many conventional science educators, science is science or compilation of knowledge about natural phenomena obtained through the scientific method. When we start to think of the issue of "science in the context of science teaching" in Indonesia, science is "a foreign culture" for "Indonesian". Ogawa (2002) states that "science" is not the indigenous culture of Japanese, but the imported culture from western countries that have entered Japan since the middle of the 19th century. Although, the fact is now many Japanese can study science since science is seen from the multicultural perspective.

Ogawa (2002) defines science more broadly as "a rational response to reality", in which "response" means an act to build reality and reality building itself. We need to see that to be rational in this context is not just to be rational in the western context, but according to regulations obtained from various types of rationales in every culture.

Based on that definition, Ogawa in Snively & Corsiglia: 2001) differentiates science into 3 types: that is 1) personal science, 2) traditional science or indigenous science) or indigenous science, and 3) Western modern science.

First, "personal science" is science in individual level and is defined as "a unique personal response to the reality". Every individual develops a particular interpretation of sensory data that he or she receives, both in the form of objects and events. The interpretation built by every individual differs from another individual (s) and depends on their previous experience. Hence, an interpretation of a reality is personal. This is similar to the constructivist's view that states that a condition does not lie in the reality itself, but an individual develops the meaning from the reality (Bodner, 1986). The personal interpretation of a concept is called conception.

Before a child learns science at school, he or she has had an idea about natural phenomena (Dawson, 1992; Suastra, 1996). The ideas are personal knowledge, that is, ideas that are formed through informal learning in understanding daily experiences, and is called prior knowledge or preconception. The student's conception, in general, differs from scientific conception, which is more complex, and involving many inter-conceptual relations, while, the students' preconceptions often occur since they only use intuitive thought or common sense in responding and explaining problems that they are facing.

Secondly, indigenous science socio-cultural science is defined as a collective response to the reality which depends on culture. The response can take the form of action to construct the reality and to build a reality and to build the reality itself. Collective here means to be believed and used by many people and do not depend on personal or the group of small thinkers. Hardesty (in Snively & Corsiglia, 2001) mentions indigenous science as ethnic- science, which is explained as the study of the system of knowledge developed from the perspective of a local culture that is related to the classification of objects and activities that are related to natural phenomena. Indigenous science interprets how the local world works through a special cultural perspective. In addition, indigenous science also has processes such as observation, classification, and problem-solving by incorporating their indigenous culture. For example, in responding

to a thunder, the traditional Balinese usually throw out objects made of iron, such as sickle, *linguist* (a type of implement to dig a hole made of iron) to their yards and bury "panca dhatu" in holy buildings to prevent a danger from thunder. The same is true for protecting rare animals and plants, the traditional people use the concept abstinence with the concept "duwe" (gods' possessions) (Suastra, 2005a).

Thirdly, normal science is defined as the collective response to reality stated and recognized by the scientific community that consists of activities and products of science in the form of scientific knowledge (Ogawa, 2002; Irzik, 2001; Stanley and Breakhouse, 2001). The Universalists mention the current modern science as a standard science and are universal in nature. There are some terms for modern science such as "standard science", "Western science", "conventional science", and "formal science". This modern science has been used since the 20th century up to present. Some people say that modern science started since the presence of atomism perspective in Greece, and others say that it started since the 20th century when scientists started to hold theories such as the theory of evolution, natural selection, and molecular kinetic theory (Snively & Corsiglia, 2001:9). Goldstein and Goldstein (1980) state that science is an activity that is marked by three things: 1) a trace to achieve understanding and to obtain an answer to reality, 2) the concept is obtained by studying principles and laws that prevail with as many phenomena as possible, and 3) the laws and principles can be tested through an experiment (testable).

3.3 Difficulties Faced by Students in Eastern Culture in Learning Science

The learning achievement of the students in science in Indonesia, including Bali, is still low. This can be seen from the results of the study by Program for International Student Assessment (PISA) in 2009 which shows that Indonesian students' literacy achievement in reading falls into the 57th rank, literacy achievement in mathematics the 61st and literacy achievement in science the 60th from 65 countries (OECD in Eleanor, 2012). Indonesia ranks the lowest tenth of PISA country participants. In addition, Trend International Mathematics Science (TIMSS) in 2007 reports about the average scores in the cognitive domain, an important aspect in the ability of problem-solving in which Indonesia ranks 36th of 49 countries in the world (Gonzales *et al*., 2008). Indonesia' score in knowing is 425, in applying 426 and in reasoning 438, all of which are below the TIMTSS average of 500. In 2015, the result of PISA study places Indonesia at the 62nd rank from 70 countries being surveyed. This problem keeps on becoming an issue in mass media news and in the national policy in the educational sector, but up to the present, there has not been any good result.

The scholars who are involved in studies on the involvement of cultural values possessed by the students in the science teaching process use a metaphor called "border crossing metaphor to explain the process of science learning from an anthropological perspective (Jegede & Aikenhead, 2000; Wahyudi, 2003:7). According to this metaphor, the students are seen as trespassers of a boundary between two cultures, that is, their daily cultural values and science values at school which is basically dominated by Western scientific culture. The word "boundary" here is "imaginary boundary", that is a boundary that is present in the mind, not a material boundary. By using this metaphor, Costa (1995) groups the categories based on their ways to enter the science culture in the classroom from their daily culture, such as what is shown in Figure 2 as follows.

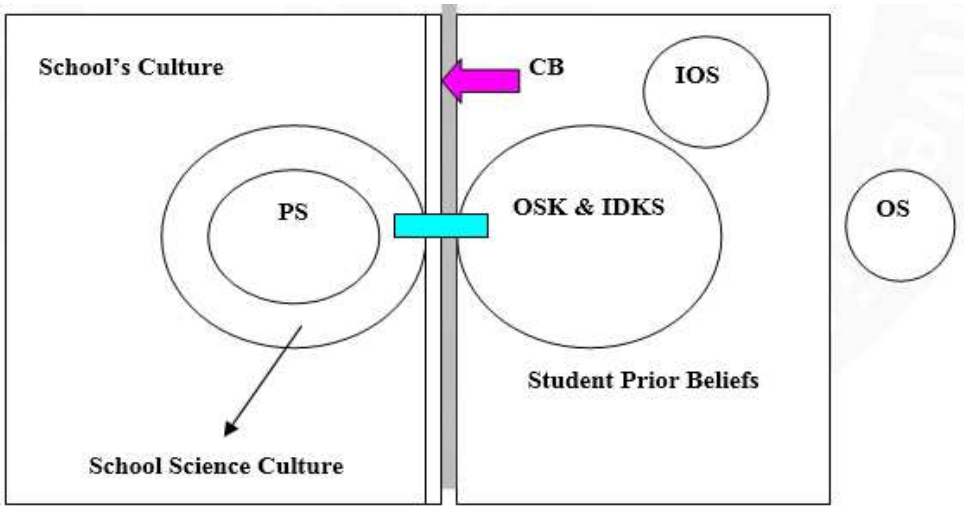

Figure 1. The process of Effort Made by the Five Groups of Students in Trespassing Cultural "Boundary"

Notes:

CB	= cultural border	IDKS	= I don't know students
PS	= potential scientist student	OS	= Outsider students
OSK	= other smart kids		

The first group is called "Potential Scientist" (PS). The students in this group can easily pass the two cultures (CB), that is, science school culture and their daily culture naturally as if the boundary is not there for them. The second group is called "Other Smart Kids" (OSK), that is, the group of students who can pass the boundary well, but they still see and recognize science as a foreign culture. The students in this group mostly like to use a "smart" way of learning science. They can develop science knowledge construct in their mental schemata and stored in their long-term memory that can be accessed only when it is needed at the time of examination. The third group is "I Don't Know Students"(IDKS), that is, a group which faces a serious problem in passing the boundary of the two cultures, but can learn to overcome it, and succeed to use the way called Fatima's Rule continually. This group may succeed in a science test, but they do not understand science concepts comprehensively. They tend to memorize concepts, not understanding them. The fourth group is "Outsider" (OS) that is the group of students who tend to be alienated during a science lesson. This group faces great problems in their effort to pass the cultural boundary. This group of students almost cannot pass the boundary. This is caused by the strength of the effect of their everyday cultural values compared to the science concepts that they learn at school. The last group is "Inside Outsider", that is a group who feel a cultural discrimination by modern science so that they feel that they cannot pass the two cultures. This group actually have a great desire, but they are alienated in the classroom/ school that does not provide for the student's prior belief. The consequence is that they feel that they feel alienated so that they cannot obtain meaningful science knowledge for their life.

Ogunniyi (in Aikenhead, 2000:8) explains that indigenous view that contrasts with Western science thought do not obstruct the student's scientific understanding and even indigenous view and scientific view on the world can be taught simultaneously. George (2001:3) states that two things. (1) in parallel collateral learning, the students can have two schemata which have fewer similarities (indigenous science cannot yet be explained by Western science) and will receive the best schemata and fit their situation. (2) Through secured collateral learning, the students can easily solve conflicts in their schemata because there are fewer differences between them. The students will gain a better understanding of the two schemata because of fewer differences (indigenous science can be explained by Western science).

In the light of the explanation above, it is clear that the students in the context of traditional community, including Bali, will experience greater difficulties compared to those from the Western countries in constructing science and scientific attitude. This is caused by differences in concept, epistemology, and the way they obtain knowledge. Hence, in science teaching at the school, there is a need to bridge the gap to ensure the harmony between Western culture and their culture as the heritage from their ancestors and part of their daily life. Thus, the students' culture in the traditional community is not lost with the coming of Western culture but can go hand in hand strengthening cultures that have existed before (enculturation)

3.4 Implementing Local Culture-Based Science Teaching Model at School

Suastra (2010) finds that 90% of the teachers state that they want to develop culture-based teaching model in their classes, but only 20% of the teachers have insights/ knowledge and ability to develop it.

Based on the need analysis above, then the phases in a culture-based teaching model to develop basic competencies consists of 1) pre-activity, 2) investigation from various perspectives, 3) concept application phase, and 4) final activity.

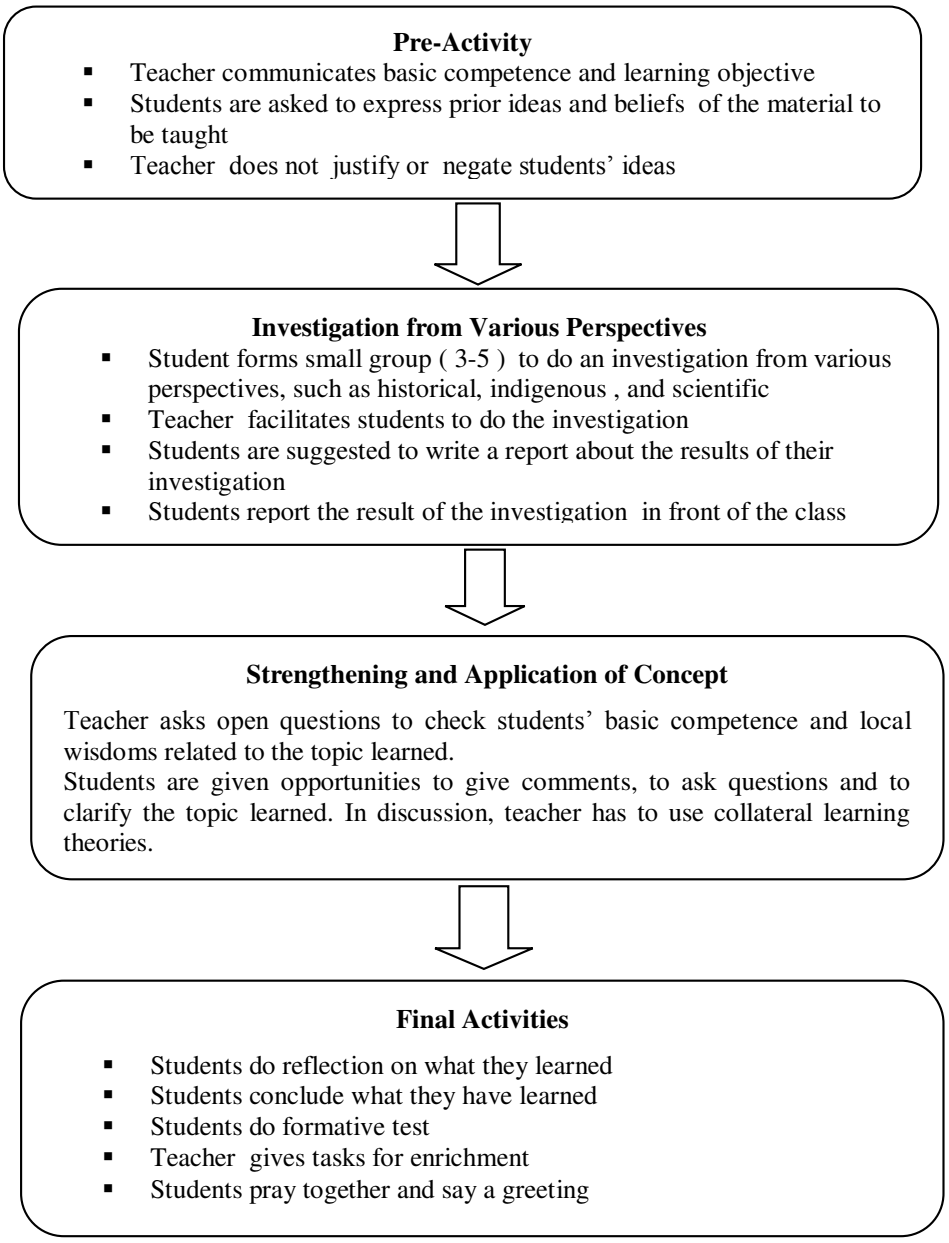

Figure 2. Phases in culture-based science teaching (Suastra, 2010)

Some principles that have to be kept in mind by a science teacher in developing local culture-based teaching as follows.

a) Give opportunities to students to express their ideas, to accommodate concepts or beliefs that are rooted in indigenous science (culture).
b) Present to students examples (discrepant events) which are actually common things according to Western science concepts
c) Play the role in identifying cultural boundary that will be passed and lead students to pass it so that it makes a sense if a cultural conflict occurs.
d) Teacher uses collateral theory in overcoming problems of differences between students' indigenous view and the theory of science (Western).
e) Encourage students to ask questions, and

f) Motivate students to be aware of the positive and negative effects of Western science on life in the world (not on the contributions of Western science and technology to the process of mono-acculturation of the elite who have special rights).

At a particular time do a presentation with an explanation using more than one theory about the phenomena through discussion. Thus, learning science is a process of enculturation where indigenous science (local culture) that has high values and has lived and developed in the society is not uprooted after learning modern science. This is in line with the view or Ki Hajar Dewantara (Dewantara, 1977) that indigenous culture possessed by Indonesians which is full of wisdom values keep growing and developing in the society. Furthermore, if the students' local culture is not accommodated into science teaching for the traditional community, then Western science learned at school will become "something that is only attached" which is ready to come off (Freire, 1976). 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.

4. Conclusion

In the light of the explanation above, it can be concluded:

The low quality of science education in Indonesia is caused by less attention to and less accommodation of local wisdom that exists in the community that is part of the students' culture by the developers of science curriculum at school. Local wisdom can be made a source for inspiration in learning and can also obstruct science teaching and learning process at school. Science teaching at school has to be seen as an enculturation process. Hence, there is a need to reform science curriculum by paying attention to the variety in the students' sociocultural background by using cultural approach based on the principles of sociocultural variety as the basis for determining science education vision, sociocultural variety becomes the basis for developing various components of the curriculum such as objectives, contents, process, and assessment and learning source and object of study have to make part of the students' learning activities. Local culture-based science teaching, in addition to being able to develop science basic competencies, and at the same time also can develop and preserve Bali local wisdom that is an integral part of national culture.

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Statement of authorship

The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

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Biography of Author

Prof. Dr. I Wayan Suastra, M.Pd was born on May 15, 1962, in the village of Tojan Klungkung Bali Indonesia. Since March 1, 1988, was appointed a lecturer in the Department of Physics Education FKIP Unud (now Undiksha). Master's degree in Science Education at the Teachers' Training College Bandung (now UPI Bandung) in 1996 and a doctorate in Science Education at UPI Bandung in 2005. The last ten years the focus of research in the field of education and learning science, especially in the context of local culture Bali.

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