Development of Indigenous Science Instructional Model

Prasart Nuangchalerm*

ABSTRACT

This study aims to develop an indigenous science instructional model. The samples were divided into two groups. Firstly, 24 experts for designing an indigenous science instructional model using Delphi Technique. Secondly, three classrooms of Mathayomsuksa 3 students for developing an instructional model. The findings revealed that Delphi technique provided ways to promote science learning through local culture and to develop student abilities. Also, the LADDA Instructional Model (Learning, Analyzing, Deciding, Doing, and Application) gained higher posttest scores in science learning achievement, values of science-culture in accord, and environmental conservation behavior than the pretest scores.

Keywords: indigenous science, instructional model

INTRODUCTION

In 1999, Thailand initiated sweeping curriculum reform in an effort to improve students' achievement and make education better serve the needs of society. In particular, it was believed that the existing curriculum failed to maximize student learning in the crucial subjects of mathematics, science, and technology. Students' scores on the Third International Mathematics and Science Study (TIMSS) seem to bear this out (Beaton et al. 1996). In addition, the existing curriculum seems unable to provide students with skills needed to tackle fast changes in social and economic areas (Ministry of Education. 2002: 1).

The current Thai National Education Act recommends that all schools should incorporate indigenous knowledge into the school curriculum. Children should learn science in their communities based on the indigenous knowledge, cultural beliefs, values, practices, and experiences of Thai citizens. The importance of indigenous knowledge related to science would be helpful in the classroom. Teaching and learning science should include the interaction and communication among students, indigenous knowledge, and scientific knowledge in various places where they live (Ogawa. 1995: 583).

Not only science plays a major role in our society, but also culture is a diverse wisdom, which is developed and served all people on the same footing as science. Indigenous people know how to survive in their local communities based on learning by doing or practical science (Ganjanapan. 2000: 197-198).

**Department of Curriculum and Instruction, Faculty of Education, Mahasarakham University, Mahasarakham 44000 THAILAND*

Bausor and Poole (2003: 117) pointed out that science learning requires consideration of how science is affected by the contexts in which it is practiced, including spirit, moral, society, history, and culture. Attention also needs to be paid to the scope and the limits of science. Cultural aspects can reinforce learning about science, that is, it contains scientific conceptions that students should learn (Yakubu. 1994; Costa. 1995; Jegede. 1995; Ogawa. 1995; Jegede. 1997; Kawagley et al. 1998; Aikenhead and Jegede. 1999; Walker. 1999; Forrest. 2000; Omoifo and Ogawa. 2001; Ogawa. 2001; Ogawa and Omoifo. 2001).

Based on the cultural capital and the way of learning in Thai culture, teaching science through local culture can promote ways of learning science. In addition, the Thai National Education Act of 1999 states that all schools should incorporate indigenous knowledge into their school curriculum. Students should have learning activities locally and gain understanding globally. This study aims to develop an indigenous science instructional model. The significance of this study occurs in school-based science curriculum and ways to reinforce science learning through local culture.

METHODOLOGY

The research procedure is provided in the following 4 stages.

Stage I: Collecting data

The researcher collected general information about school and community for understanding indigenous knowledge, local culture, and *PAH POOH TAH* related to science learning area under the theme of life and environment. The content of the *PAH POOH TAH* in three domains of science: knowledge; process; and attitude towards science were analyzed.

Community survey Baan Don Hun, Baan Don Jode, and Baan Nonchantuek were the target groups for studying local culture, way of life, and science learning transaction. Gathering the data related to science context of indigenous knowledge for *POOH TAH* was done. In addition, research project and its procedure were discussed between science teachers and the researcher.

Stage II: Developing the instructional model

The Delphi technique was used to obtain a consensus from experts in various field of study. Participant recruitment: The target of this study was to investigate the opinion of 24 experts who concern about the reinforcement of science learning through local culture. Five science curriculum developers, 5 educational technologists or evaluators, 5 ecologists or environmentalists, 4 national science teachers or master science teachers, and 5 indigenous specialists were selected. All the experts' responses were analyzed numerically by calculating an average response in order to determine the degree of agreement between the groups. The results from each step in the process were returned to the experts so as to collect their revised individual opinions.

There were two rounds of the survey and both are consisted of a list of Likert-scale items. First round, to each prompt the experts were to indicate their level of agreement with the statement by choosing from four options: strongly agree, agree, disagree, and strongly disagree. Once returned, descriptive statistics for the group ratings were calculated for the median, and interquartile range. Second round, the ratings of research statements and rankings of major research categories by the group in the first round were compiled. Participants in this round again ranked the major research categories as they did in the first round. But this time the descriptive information about how the group responded was provided. Participant experts were asked to review each item, consider the group response and then re-rate the items by taking the information into account.

Stage III: Designing learning activity for indigenous science instructional model

Data from documentary study and community survey, synthesis science curriculum, and Delphi study were analyzed. The theories of science curriculum development were studied. Then the researcher explored the theories of lesson plan construction based on child-centered approach. The lesson plans was designed by the use of Basic Education Curriculum 2001 of the national science education standards: subcategory 2 (Life and environment); subcategory 8 (Nature of science and technology); of the national social studies.

Stage IV: Implementing the indigenous science instructional model

Researcher implemented lesson plan with three science classrooms The total periods were 20 hours per classroom. The learning process employed the LADDA instructional model into science classroom. All periods were taught and manipulated by the researcher. The one group pretest and posttest design were examined. Science learning achievement, values of science-culture in accord, and environmental conservation behavior were measured before and after implementation.

RESULTS

Delphi study

The results Delphi study reflect the consensus of opinions of experts. Then the data were analyzed and prepared for the first round of Delphi questionnaires. It was used to ask the member of experts by Delphi technique. In addition, this round allowed them to provide more suggestion and discussion in the end of each issue. The second round questionnaire featured the panel rating for 90 statements. Median and Interquartile range were presented to all panel members. This round, panel members were asked to re-rate the items and taking the information into account. The information of Delphi panel members can then fulfill the reinforcement of science learning through local culture and is presented in Table 1.

Table 1 Demographic information of expert participants completing the Delphi study

Demographic item	First round n	First round %	Second round n	Second round %
Gender				
Male	10	55.56	8	57.14
Female	8	44.44	6	42.86
Age				
30-40 years	4	16.67	2	14.28
41-50 years	8	33.33	6	42.86
51-60 years	6	25.00	6	42.86
Education				
Master degree	7	38.89	6	42.86
Doctoral degree	11	61.11	8	57.14
Institutional affiliation				
University	15	83.33	12	85.72
School	2	11.11	1	7.14
Public organization	1	5.56	1	7.14

Instructional Model

To the study, the researcher develops learning process by conducting learning activity based on LADDA instructional model. This instructional model can be given more details in terms of Learning, Analyzing, Deciding, Doing, and Application (Nuangchalerm. 2006). The five steps of LADDA instructional model related to the taxonomy of educational objectives (Bloom et al.1964) are used for science teaching. This model is developed based on the educational objectives. The inquiry method is also considered and adapted for appropriate learning management (Science Curriculum Improvement Study. 1974; Savathanaphaibul. 1983; Biological Science Curriculum Study. 1990; Collete & Chiappetta. 1994; Savathanaphaibul. 2003). Student will learn science with inquiring mind. The values of science will also be promoted for conserving their local environment through local culture. The scientific knowledge and indigenous knowledge will change them to have positive behavior, beliefs, and interest about local environment management (McPherson & DeStefano. 2003: 141).

Three science classrooms of Mathayomsuksa 3 were selected for the implementation. Course description and unit of learning were designed for 20 hours. Unit of learning was divided into 3 subunits i.e. biological diversity, ecological system studies, and man and environments. In learning process, the researcher employed the LADDA instructional model during the implementation. Learning outcomes were examined before and after curriculum implementation.

Learning outcomes

The one group pretest and the posttest design was conducted. Science learning achievement and the values of science-culture in accord were measured before and after curriculum implemented. Also, environmental conservation behavior was monitored during the time of study.

Science learning achievement students' science learning achievement of three schools has been positively developed. There are significantly different in both pretest and posttest scores at .05 level. Also, values of science-culture in accord of the students from three schools consists of 3 criteria: moral and ethics, art and way of life, and self-sustainability. The scores for each criterion tend to be higher than those of before curriculum implemented. Three schools are significantly different in both pretest and posttest scores. Inaddition, environmental conservation behavior of the students from three schools are significantly different between pretest and posttest. The scores before proposed science curriculum implemented are higher than those of after implementation.

Discussion

To students' life in their community, science learning should be developed in the ability of problem-solving, thinking globally, acting locally, and bringing science to serve the way of life (Hadzigeorgiou & Konsolas. 2001: 40). It should be pointed out that science education should not only provide students with opportunities to answer questions e.g. "how do we know?", "why does it happen?", "what can we do with our knowledge?", "how can we communicate these ideas?", but also the question "why do we know?" will propose more important issues to discuss for the purpose of learning. Students will always feel what they are supposed to learn and live with community.

Delphi study

The results of Delphi method provided how to create science learning atmosphere by the use of local culture and to serve students' development in both scientific knowledge and local culture traits. Students will merge the scientific knowledge from their own culture with the experimental techniques they have learned.

Aikenhead (1997) provided a perspective view for science curriculum that learning results were the ever-changing interaction among the personal orientations of a students, the subcultures of a student's background (family, tribe, peers, school, media, etc.), the culture of his or her nature, and the subcultures of science and school science. In addition, Snively and Corsiglia (2001) proposed a cross-cultural perspective referring to traditional ecological knowledge. It increased interesting indigenous knowledge, local culture, culture traits of western science, and the growing need for environmental sensitivity.

The study shows the theoretical and practical ways to serve science learning for students. It engages science and science education to meet local culture, the way of life, and daily life activities, which interact with indigenous science. Detailed responses from the experts provided valuable suggestion to promote process of science, pedagogical practice, content knowledge, conservation behavior, and value of science-culture in accord. Also, it provides the ways to promote science learning and local culture studies. Teachers can bring these opinions into classroom by creating educational curriculum based on school and community contexts. Students will build a body of knowledge about the natural and physical worlds. Ways of thinking of indigenous people about the world reflect worldviews, which are distinctive from some scientific knowledge. Indigenous science is not separated from daily life. They are interspersed with ways of communicating, practicing, and thinking (Kawagley et al. 1998: 137).

Thailand has diverse cultures which science can play its role in the classroom. Science disappears rapidly and alerts us to concern about the loss of biological diversity, environmental destruction, climate change, and species extinction. However, we know very little about how we are losing local culture and how we can teach our children about indigenous science.

LADDA Instructional Model

The LADDA instructional model makes an understanding by stimulating the power to change learning environment appropriately. The science learning process involves active construction of the representation in a problem-solving. Then, understanding how scientific concepts were developed aid the development of instructional strategies (Nersessian. 1991: 144-15). Students can learn science and construct scientific knowledge by the acquisition of interactions with the environments and the intervention of the school (Pines & West. 1986: 585; citing Vygotsky. 1962).

The findings from observations suggested that students should pose basic ecology competency. It is noticed that *PAH POOH TAH* and ecological concepts are interrelated. From interviewing teachers and students, it is formed that they spent more explanation about *PAH POOH TAH* and some acquired additional ecological concepts.

Students obviously awared of what they were doing which was a part of their learning. Teachers need to know a range of teaching and learning strategies because different steps of teaching strategy will suit different students (Fairbrother. 2000: 8). Science teaching is based on certain assumptions about how students come to understand scientific knowledge and can use it in the community.

The LADDA instructional model works best with the meaningful learning science involving the understanding scientific and local culture. Thus teachers need to pursue class activities that engage students in using scientific concepts to describe, explain, or make predictions about the nature. Students living community have the ways of talking and thinking about the events and phenomena, which are influence to students to be interested in science.

Five steps of the LADDA instructional model provided an alternative way of thinking and doing based on the accordance of science and local culture. The positive reinforcement occurs when a stimuli is presented or added after the learning behavior is performed (Sternberg. 2004: 231). The learning science process originates in local community or social situations and language is a center of teaching and learning science. Teacher sometimes provides the local language to make more clearly explanation in terms of talk to local culture, which provides the conceptual tools for thinking about science. The socio-cultural practice and social interaction are privileged mechanisms for explaining. The area of communication as an agent of a particular action that uses an object to attract the attention are considered. The local language can influence the effective communication (Vila. 1996: 192). It increases the probability of operant behavior associated with the learning experiences in both indoor and outdoor activities.

The strength of the connection between response and stimuli of science learning is named as the Law of effect. The idea of reinforcement serves the strength not so much but rather to strengthen the response itself or intrinsic factors. It also has incentive motivation between science and local culture understandings (Petri & Govern. 2004: 169). However, indigenous science plays its role in science classroom by education allowing a genuine meeting place between local and universal aspects. Learning process might want to ensure a relevance to the student's experience, interest, capabilities and cognitive development. It may be very different from the context in which new conception, skills and attitude towards science developed (Swift. 1992: 7). The science learning for Thai society is challenging towards understanding the concept of learning and developing science for all. Science learning needs to have a collateral learning via local context as much as possible.

Learning Outcomes

Science learning achievement

The findings indicated that the science learning achievement of students has been improved. The cognitive development was derived from the LADDA instructional model in which students were reinforced by science learning through local culture. It provided students to associate with a variety step of learning process and learning activities. Students can gain their cognitive abilities in which science learning plays its role in local culture. Students from three schools are significantly different in their developmental cognitive. The LADDA instructional model is a positive stimuli which responses student in knowledge, comprehension, application, and scientific process skills.

In the case of a student, namely Mr. Duck who is an example for explanation that how student becomes paying attention in science classroom during the time of study. Before implementation conducted, Mr. Duck felt so bored with the science classroom. He was often absent during science classroom and avoided school activities. The school administrator decided to talk about this situation with his parents. When indigenous science instructional model was implemented. Researcher found that Mr. Duck decreased his negative behavior. He was ready to study and cooperate with friends in science classroom. The social reinforcers e.g. friends, teacher are included for science classroom. Also, activity reinforcers e.g. indoor or outdoor activities are transmitted by science curriculum and learning activities and the reinforcers can raise his learning abilities and attitude towards science learning.

The science learning activity and LADDA instructional model reinforced students' learning. Students can gain cognitive ability, which is explained in terms of zone of proximal development. They understood an accordance between science and local culture based on the diversity of learning activities in both indoor and out door classrooms. Science learning through local culture can raise students' scores of learning achievement. Science and local culture have the same origin or source of knowledge from the nature. They can be integrated and introduced into schools. However, this study needs more times for development to verify that students could probably gain more scores than this study.

Values of science-culture in accord

Students can gain their values of science-culture in accord which science learning plays a major role in local culture.

This resulted from the LADDA instructional model in which learning science through local culture was promoted. The relationship between achievement and value is very strong. It can be discussed that when apply the LADDA instructional model then the achievement and value scores increase. Values of science-culture in accord of the students concern three kinds of the value (attainment value, utility value, and intrinsic value) that are relevant to achievement (Stipek. 1993: 22-23; citing Eccles. 1983). An activity of the attainment value can affect an individual to create self-concept. Students presumably engage in activities in order to develop competencies that are consistent with their concept. Utility value concerns the usefulness of a task by means of the achievement goals that might not be related to the task itself. Intrinsic value engages in for its own sake, rather than for some other purposes. Regarding, the values of science-culture in accord of the students, the pretest and posttest scores show that they are significantly different at .05 level.

The scores of values of science-culture in accord and achievement are raised. The science curriculum and the LADDA instructional model influenced the mental development. Students are often stimulated by science curriculum. They appreciate in own their culture or community. The scores of values of science-culture in accord should be promoted by using diversity of learning activities. In addition, the dimension of mind or affective domain should have been conducted in longer time.

The goals of the relationship between educational science and learning science need to be critiqued. The technical and political issues should be concerned. Incorporating local culture into science curriculum may be one way of enhancing student self-esteem in local community as well as providing a bridge to modern science (Gaskell. 2003: 247).

Environmental conservation behavior

Students' scores in three schools is significantly different at .05 level. The scores after indigenous science learning activity implemented are higher than those of before implementation. The results of this study influenced by the LADDA instructional model in which environmental conservation behavior was promoted. Students concern about the currently declining of biological diversity in their community. They learned how human activities threaten the nature. The future practical uses and values of natural resources are unpredictable because biodiversity is more interesting and more attractive. Our understanding of ecosystem is insufficient such as there could be certain impact of removing any component (Glowka; et al. 1994).

The importance of decision-making needs the best possible scientific information and people's awareness to sustain the environment (Grace & Sharp. 2000: 49-50). The criteria of local culture and environmental conservation require consideration of how science is affected. They are practice, spiritual as well as moral (Bausor & Poole. 2003: 311). The relationship between environmental concerns and conservation behavior is linked to values (Schultz; et al. 2005). The awareness of environmental concerns is considered in science education and social responsibility.

Science and culture originated from nature, which are inextricably linked. Students concern and aware of all life taking part in the environment. The rise of commercial interest in biodiversity and indigenous knowledge tends to increase greater problems, since the components or products of biodiversity and natural resources in each region are collectively destroyed. Students should obtain the suggestions about the best ways to conserve environment in terms of relearning ecological knowledge, local culture, or sustainable principles that our society has lost (Posey. 1998: 54).

Environmental conservation behavior is more effective based on the learning activities in both indoor and outdoor classrooms. Students are stimulated by the lesson about environmental conservation behavior, which includes the awareness of environment. The lesson influenced the intrinsic which later links to the extrinsic. However, limitation of this study depends upon writing skills of the students to express their feeling. Teacher should employ observation together with interviewing to monitor the environmental conservation behavior.

RECOMMENDATION

Recommendation for Teacher

1. The ways to apply the local culture into science subject and target group should be expressed as a favorable opinion in school hour. The strategies in applying local culture for teaching in particular region should use the culture originated in that region and the culture should be able to be explained by science. The diversity of teaching methods and of learning activities should be considered.

2. Teachers should encourage science learning through local culture based on the needs of students, students' attention, teachers' background, and community cooperation in learning processes. It is important that teachers recognise and encourage local culture in relationship with scientific explanation.

3. Teachers should be aware of the subtle differences in thinking, verbal response, and behavior of their students. Teachers should give more perceptive learning approaches and more appropriate response to students. The other local cultures should be considered in science learning.

4. Teachers should be aware of the changing world as well as students' thinking is also shaping. The learning science through local culture needs to be encouraged due to the importance of its role in society. Students should have experiences of moral, ethics, and values of science-culture in accord in terms of science curriculum. Indigenous specialists should be invited to come into science classroom to teach local contexts, whereas teachers can teach universal contexts.

5. Teachers can prepare learning materials and learning resources found in local community. The learning resources should be found near schools because the students can visit easily.

6. Teachers should reinforce students in terms of local language when they face to difficult technical terms or situations. Students sometimes need a teacher to threat them friendly and help them happily understand the subject. The formal speeches from the students to the teacher should be deceased because the students feel more comfortable and convenient if local language is used.

7. Teachers have to develop new learning management for science learning through local culture. The LADDA instructional model is suggested for alternative choice for learning

development. It is an innovative approach of science learning through local culture. Teachers can apply this learning process into the classroom.

Recommendation for administrator

1. The reinforcement of science learning through local culture has affected the structure and functioning of school, curriculum, teacher, student, and community. The school should be incorporated in science curriculum. At the same time, self-esteem and appreciation in local culture should be promoted. The most successful way is to introduce the importance of both local culture and learning science to students, parents, and teachers involved.

2. The values of science-culture in accord and environmental conservation behavior are the important factors in indigenous science learning. Students should have the opportunity to participate in some local cultures and get more information in terms of scientific explanation.

3. School should allow indigenous specialist to participate in science learning. Students will have new conceptual system that how science and local culture interact in their everyday life. Also, school should promote teacher to develop science curriculum including science and local culture.

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