

Fragrant Bamboo: The Constructivist Inquiry-based Science Project Curriculum Implementing Place-based Education for Preschool Children in Taiwan Tayal Indigenous Tribe

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Abstract

The collaborative teaching research was conducted in northern Taiwan's Tayal indigenous tribe to practice a constructivist inquiry-based science project curriculum implementing place-based education for kindergarten children. Research participants included 2 classroom teachers and 15 young children. Entering the natural tribal context, the researcher collected data through field observations, interviews, and other documentation. Qualitative method was adopted to analyze research data. A bamboo project was implemented relating to children's life experiences. Research findings reveal: (1) teachers and children managed to co-construct a science project curriculum based on local resources and Tayal traditional knowledge (2) children developed basic scientific concepts and knowledge about natural plants through the inquiry-based project curriculum and (3) teachers regarded their roles as being co-learners with children and realized the importance of children's active involvement in the constructivist inquiry-based teaching. The result can help to improve science teaching/learning for indigenous children by utilizing environmental resources as well as traditional knowledge in future education.

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Background

Knowledge communication enables people to admire different cultures beyond their own surroundings. As the importance of cultural diversity is emphasized in modern society, the government has paid more attention to multi-cultural and indigenous education in Taiwan (Tseng & Ho, 2009). Advocates of educational reform claimed that indigenous curricula should be planned from indigenous students' worldview (Fu, 2004 Jerez, 2005), and that importance should be placed on traditional culture and life experiences (Brayboy & Castagno, 2008; Castagno & Brayboy, 2008) as well as learners' context knowledge (Bang, 2010). To retain the originality and uniqueness of indigenous culture, educators should respect indigenous knowledge and design curricula based on the indigenous worldview. The researcher believes that, when the curricula content meets indigenous children's interests and connects to their real life experiences, children can achieve remarkable performance in school education (Bang, 2010 Riggs, Robbins & Darner, 2007). The above opinions meet the claims of place-based education—letting students learn from their environment and life experiences (Smith, 2002; Sobel, 2004). Under such a rationale, the researcher attempted to improve science teaching/learning for indigenous young children by working collaboratively with early childhood teachers in utilizing tribal resources and cultural heritage, adopting the perspectives of place-based education in the implementation of a science project curriculum in the Tayal indigenous context.

Practicing Place-based Education in Indigenous Children's Science Learning

Place-based education is an educational reforming orientation which integrates the content of the curriculum and utilizes natural and socio-cultural materials as learning resources. According to Sobel's (2004) definition of place-based education, it is

the process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science, and other subjects across the curriculum. In science teaching for indigenous children, it is valuable to embed natural resources as well as traditional knowledge into the curriculum. Since children's ideas about science are personal and social constructions that are affected by their personal experience and the culture they live in (Hartman & Glasgow, 2002), teachers should let children learn from their own culture and natural environment, acquire real-world problem-solving skills from the familiar fields, and build learning on the basis of local atmosphere and life experiences.

Research findings have supported the advocacy of bringing local knowledge and environmental resource into indigenous students' learning (Bang, 2010 Barnhardt & Kawagley, 2005 Chi & Liu, 2000; Glasson, Frykholm, Mhango & Phiri, 2006; Knapp, 2008; Lauer & Aswani, 2009 Riggs, Robbins & Darner, 2007; Shizha, 2007; Snively & Corsiglia, 2001). Educators should provide more equitable and culturally responsive schooling within the current context of standardization and accountability to meet the real needs of indigenous students (Brayboy & Castagno, 2008; Castagno & Brayboy, 2008).

The importance of contextualized knowledge within indigenous communities highlights the school education for tribal students. In the early years, the indigenous science curriculum for kindergarten children should be aimed at developing basic science process skills, knowledge, and values among learners for deeper understanding of their local environment. Also, it should make science culturally responsive, compatible, and relevant to the learners by utilizing science-related indigenous knowledge (Pawilen & Sumida, 2007).

While there are still very few studies on place-based education in Taiwan, the practice of such an educational perspective can provide a worthwhile reference for indigenous science education. To apply the theoretical ideas of place-based education, the researcher aimed to utilize the combination of cultural assets, traditional wisdom,

and the natural ecological resources as learning materials in teachers' planning of science project curricula for indigenous children. The close cooperation and interaction between schools and communities, parents and teachers, makes it the best educational resource. Furthermore, learning from the local environment and life experiences should help to increase young children's learning motivation and interests.

Constructivist Inquiry-based Science Project Curriculum

In order to practice place-based education, teachers should let students go deep into the environment, and construct knowledge not from books but from the inquiry process happening in the real world. When children learn science, the knowledge constructions result from observation, examination, questioning, and analysis of experiences in the external world. The process is consistent with an inquiry approach. Indicated in the National Science Education Standards (NSES), inquiry refers to the activities in which children develop knowledge and understanding of scientific ideas (National Research Council [NRC], 1996). The inquiry process can occur in constructivist teaching.

Chaille and Britain (1991) claimed that young children can be encouraged to construct their own understanding if teachers perform constructivist teaching roles. These roles largely function as a facilitator of knowledge construction (Martin, Sexton & Gerlovich, 2001). Being the "facilitator" in children's science learning, a constructivist teacher may provide assistance but leave autonomy to children as they should learn to think independently. To implement constructivist teaching, an inquiry-based project approach is a practical pathway. According to Katz and Chard (2000), a project is an in-depth study of a particular topic that one or more children undertake, and consists of exploring the topic or theme over a period of days or weeks. A main aim of project work in the early years is to strengthen children's dispositions to be interested, absorbed, and involved in in-depth observation, investigation, and representation of some worthwhile phenomena in their own environments (Katz & Chard, 1998).

The most important element in the project curriculum is: children should actively participate in the inquiry process, and find out the answers on their own through the persistent investigation.

To see how children change in their concepts, thoughts, competence, and behavior, the project should be a long-term investigation of a particular topic, rather than a collection of independent activities. Early childhood teachers may provide opportunities for young children to construct the project content based on their own interests to enhance learning motivation. Likewise, environmental resources and children's life experiences also provide teachers with valuable references in curriculum planning.

Research Purpose

The collaborative teaching research was based on theoretical ideas of place-based education implementing a constructivist inquiry-based science project curriculum in Northern Taiwan's Tayal indigenous tribe. With the belief that natural exploring and real life experiences were essential to children's science learning, the research focused on utilizing environmental resources in curriculum planning and aimed to improve science teaching/learning for indigenous young children. The research purposes are listed below:

1. To understand children's and teachers' process of co-constructing a science project curriculum utilizing cultural/ecological resources to implement place-based teaching and learning.
2. To analyze children's science-related concepts development in the project curriculum.
3. To understand teachers' educational reflection in constructivist inquiry-based teaching.

Method

One of the best ways to understand school science as inquiry is through a visit to a classroom where scientific inquiry is practiced (NRC, 2000). In order to obtain the qualitative changes of children's science-related inquiry behavior as well as conceptual development in natural settings, the researcher adopted a qualitative method, entering tribal villages to observe and collect data. In the natural tribal context, the researcher worked collaboratively with kindergarten teachers to implement the place-based science project curriculum.

Field and Participant

The research was conducted in YS kindergarten located in FS Township, TY County, Taiwan where most of the residents were Tayal indigenous people. One of a total of 14 indigenous tribes in Taiwan, the Tayal tribe is distributed in the northern part of Taiwan's Central Mountain areas. Farming and hunting are their traditional ways of living (Council of Indigenous Peoples, Executive Yuan, 2008). Tayal people are good at utilizing natural plants as materials in making clothes, daily utensils, hunting tools, and other living necessities. This gorgeous indigenous tribe lives amidst rich natural resources and spectacular landscape.

The research participants were young children and school teachers in the tribe. There was only one class of 15 children in YS kindergarten, along with 2 certificated early childhood teachers. The age level of these young children ranged from 4-6 years old.

For thousands of years, Tayal indigenous people coexisted peacefully with the surrounding Nature, accumulating plentiful wise traditional knowledge in dealing with the world. It was the tribal elders' wish to involve young children in understanding Tayal culture during their early years, while learning mainstream knowledge at the same time. Hence, to introduce traditional Tayal wisdom into children's school curricula was a significant mission for educators in indigenous education.

Process

The research took place in certain classes during the second semester of the academic year of 2007 (starting in February, 2008, and ending in June, 2008)*. The research process included study group meetings, field observations, and interviews with teachers as well as children.

Study Group Meeting. The study group meetings were scheduled on Thursday afternoon, in the third week of every month, hosted by the researcher, with classroom teachers as the group members. Reading materials included: theoretical books of constructivist teaching, inquiry-based approach for early childhood, and Tayal cultural materials related to the project content. During study group meetings, the researcher and teachers read and discussed about theoretical ideas, concepts, and examples of constructivist inquiry-based approach. After meetings, teachers understood basic principles of place-based education, and developed practical ideas on how to plan a project curriculum suitable for indigenous children. As a result, teachers acquired the skills to co-construct place-based curriculum content collaboratively with young children. The theoretical knowledge was learned from book reading and group discussion, and was put into practice in project planning. On the other hand, the actual teaching experiences of implementing the constructivist inquiry-based science project curriculum were brought back to the meetings for further group discussion.

Field Observation. Other than study group meetings, the researcher entered the classroom to observe, taking photos, videos, and field notes to collect data from the science activities that research participants engaged in. Field observation took place in certain classes when the topics were relevant to scientific inquiry. Classroom teachers also helped to record children's inquiry behavior happening in daily activities. There were three important points to be observed: (1) research participants'

* The research was the second year study of a three-year project titled "Tribe as classroom, classroom in the tribe: A collaborative teaching research on the co-constructing and implementing process of place-based science project curriculum for indigenous young children in northern Taiwan Tayal tribal village."

co-constructing process of the constructivist inquiry-based science project curriculum (2) children's scientific exploration and knowledge development process when the curriculum was implemented and (3) teachers' educational reflection and belief change during project implementation.

Interview. During the research period, when any doubts about practical teaching occurred, the researcher arranged informal interviews to clarify the questions; meanwhile, teachers could have a chance to explain and interpret their ideas. Formal interviews with teachers were conducted at the end of the semester to collect and analyze teachers' belief changes, and other retrospection after the project implementation.

Data Collection and Analysis

The researcher collected data during study group meetings, field observations, interviews, and from other documents. While the project curriculum was being implemented, activity documents were collected including: teaching plans, activity records (with teachers' reflective notes), and children's science learning portfolios. Photos, audio/video tapes, and field notes were recorded in field observations. Verbatim texts of study group meetings and interviews were analyzed to understand participants' concepts, perspectives, and beliefs.

Qualitative analysis was adopted in this research. The researcher repeatedly examined research data and classified them by different categories applying thematic analysis (Aronson, 1994). The researcher focused on identifiable themes and patterns according to classified categories, then combined and categorized related patterns into sub-themes. To ensure data accuracy and authenticity, participant/peer verification was conducted. The verbatim texts were checked by the interviewees to correct mistakes or vague parts. Meanwhile, to avoid personal bias, the researcher invited expert colleagues with qualitative research and indigenous education backgrounds to discuss data analysis and classification. Multiple methods (field observation, study group meetings, document analysis, and interviews) and multiple resources were used to

cross-verify the data as the researcher adopted triangulation (Denzin & Lincoln, 2000) in data analysis to ensure trustworthiness.

Research Findings

Research participants co-constructed the science project curriculum based on traditional culture and life experiences. As a result of the interactive construction process between children and teachers, bamboo, one of the most typical and essential resources for Tayal people, both traditionally and contemporarily, was chosen as the theme of the children's project curriculum. In the indigenous culture, to utilize natural plants in daily life is a prevalent tradition. The place-based teaching/learning process and important research findings in the constructivist inquiry-based science project curriculum are presented in the following results.

Part I: Practicing Place-based Teaching & Learning

In the project curriculum which was conducted within a semester, children and teachers went through a series of inquiry activities based on environmental resources, life experiences, and traditional knowledge. Their practice on place-based teaching and learning is shown below.

Nature as a Big Classroom: Environmental Resources Benefited Children's Exploration

To practice place-based education in young children's science learning, teachers encouraged children to explore their surrounding environment and look for interesting things to observe. Children used sensorial observation and expression when they found "ruma" (bamboo, in Tayal indigenous language) and "ali" (bamboo shoot, in Tayal language) on the campus.

Exploring "Ruma". In Tayal people's life, bamboo is one of the most common plants used in making tools or containers, thus it's quite familiar to Tayal young children. The class started with a discussion on bamboo's characteristics.

C13* : “It can make sounds!”

C2: “It smells good.”

C: “Thorns of the leaves can hurt me. It’s sharp, hard, and with a line on the surface.”

(Field note, 2008.04.21)

Some children touched the bamboo with their fingers, while some were trying to make sounds by blowing into the hole. Another frequently used experiencing method was to smell it and compare it with other plants. To encourage further exploration, the teachers took children into their surrounding world and both teachers and children were happy to find natural learning materials everywhere. During the exploring process, children started to use sensory organs to observe bamboo’s characteristics. As the beginning stage of a science activity, children could only observe from the appearance, however, these findings had made future scientific inquiry possible.

An “Ali” on the Ground. When children were rambling around a bamboo forest beside the campus, one child found a bamboo shoot on the ground, and started a close observation of the bamboo shoot. Children were good at using analogy to describe objects or phenomena in a way closer to their understanding of the world. Here are some examples demonstrating how children represented the bark of a bamboo shoot.

C4: “It’s a bamboo shoot’s clothes.”

T: “Why should it wear clothes?”

C10: “Like us, you wear clothes so you won’t get cold.”

C12: “Yeah! Clothes can protect the little Ali.”

C2: “Without clothes, a mosquito might bite the little Ali.”

C4: “Then the little Ali will get sick, or it will get rotten.”

(Field note, 2008.04.29)

* “C” refers to children; “T” refers to teacher(s); “C” with a number refers to a particular child.

Science learning starts from a good observation. For indigenous children, being surrounded by Nature enables them to have a wider learning environment. From the perspective of a place-based educator, extending the classroom beyond the four walls of the classroom and the two covers of books brings learning closer to children's lives (Knapp, 2008).

Life Experiences & Traditional Knowledge Helped Children to Develop Scientific Concepts

Other than the natural environment, community resources supported the development of children's scientific concepts. In the early years, children should be encouraged to learn science from their life experiences and to find pleasure in the learning process. In this research, children learned basic concepts of bamboo from their daily activities and from community members' wisdom as shown below.

Exploring the Bamboo in Daily Playing Activities. When probing into indigenous children's play world by recording their activities, the researcher found that it was not only a joyful time, but also a great opportunity for children to acquire knowledge of objects they were playing with. In the following interesting games, children used their imagination to play with the bamboo.

- *Play a tug of war with bamboo:* Realizing the toughness of bamboo, children used it as a rope in a tug of war game.
- *Lift up a "boar":* A boar(a kind of pig living in the mountains) is quite familiar to indigenous people. Children played a pretending game to lift up another child with a piece of bamboo as if he was a "boar". Most children expressed that they were not afraid of falling down because the bamboo was hard enough.

(Fieldnote, 2008.04.29)

Through the interactive playing activities, children learned more about the physical characteristics of bamboos: they're hard, strong, and difficult to break. A simple thing could easily arouse children's curiosity and interests; moreover, learning from daily playing activities enhanced children's motivation and increased their active involvement. Playing activities could help to firm their concept development as such experiences were closer to their lives.

Wise Utilization from Traditional Knowledge. Besides children's own experiences, traditional knowledge from community members also aided children's learning. During the exploring process, teachers connected the school curriculum with children's family experiences, which helped to introduce tribal wisdom into the classroom.

In a group discussion, the teacher encouraged children to share their family experiences.

C9: "It can be a water container, or a milk container."

C1: "Grandpa cut the bamboo and made a crib for the little baby to sleep."

C4: "Uncle used ruma to make chairs and tables."

C10: "Dad built a house for Grandma with bamboo."

C1: "The bamboo shoot's clothes can make a leaf hat, and wrap steamed rice."

C15: "When it rains, my Grandma puts on a bamboo leaf hat, so she won't get wet."

(Field note, 2008.04.30)

In Tayal people's life, they use bamboo as major materials to make utensils. From the tribal elders' wise utilization examples, children had opportunities to understand the containing function, constructing function, and other clever usage of bamboo. As Gruenewald (2008) advocates, one of the main goals of place-based education is to expand the landscape of learning opportunities among and between students, educators, and community members, so the practice of connecting school and com-

munity in this research related children's learning more closely to their living world. The involvement of parents' and tribal elders' knowledge not only helped to broaden children's vision, but also connected school learning with life experiences more tightly. The findings also corresponded to the researcher's claims that elders' involvement is critical to ensure cultural connection and continuity (Riggs, Robbins & Darner, 2007).

Hands-on Activities Introduced Children to the Traditional Knowledge

Besides the above wise utilization, using bamboo tubes to cook steamed rice is a very special and typical Tayal custom. The teachers prepared materials for children to experience the traditional wisdom by making "steamed rice in a bamboo tube". During such hands-on activity, children had a chance to practice cooking rice, use different containers to compare the result, and to find out the function of the membrane in the bamboo.

Phase 1: Observe the Bamboo Tube. The teacher picked up a section of bamboo tube and gave children a chance to observe.

The teacher pointed to the membrane inside the bamboo and asked: "What's this?"

C8: "It's the skin, very thin."

T: "Should we remove it?"

C9: "Yes, it's dirty."

C7: "You'll get stomachache if you eat that."

(Field note, 2008.05.06)

When some children insisted on removing the membrane, others proposed that they would rather keep it. So they decided to do an experiment.

Phase 2: Cook the Rice with a Bamboo Tube. Children worked cooperatively to

put some rice and water in the bamboo tubes, and then put the bamboo tubes in a boiler. When the rice was steamed, they cracked the tubes with a little hammer and were surprised to find that, the rice was covered perfectly with the membrane.

C3: “It was the skin that covered the rice.”

C9: “Now we can eat the skin.”

(Field note, 2008.05.06)

In fact, it was a brilliant method to use the natural membrane as a protection to prevent the rice from being stuck on the bamboo tube. Only when children actually experienced the process could they have a clear understanding and vivid memory of the newly learned knowledge.

Phase 3: Compare Different Containers. Furthermore, to compare the different aromas of rice cooked within different containers, the teacher created an activity called “make a blind guess”. Children tried to determine the correct container by smelling the rice cooked in a bamboo tube and that cooked in a steel cup.

T: “What’s the difference between the rice cooked with a bamboo tube and a steel cup?”

C9 (smelling): “This smells like bamboo, and that doesn’t.”

C14: “This (rice in a steel cup) doesn’t smell delicious.”

Consequently, the children all gave correct answers about the containers used to cook the rice.

(Field note, 2008.05.07)

After practical experience in the activity, children acquired basic understanding of the traditional knowledge of making food with bamboo. The experience was close to children’s daily life as making food containers from bamboo was prevalent in Tayal

tribes.

When practicing the perspectives of place-based education, one of the primary strengths is that it can adapt to the unique characteristics of particular places, and can help overcome the disjuncture between school and children's lives (Smith, 2002). Science education for indigenous young children in this research benefited largely from Tayal traditional knowledge and life experiences, as teachers made a good use of environmental resources in their place-based teaching.

Part II: Children's Concept Development in the Inquiry-based Science Project Curriculum

In this section, the researcher presents children's conceptual development as an outcome of implementing an inquiry-based science project curriculum including measuring skills, concepts of bamboo nodes, and knowledge about rhizomes.

Children Developed Measuring Skills When Observing the Growth of a Bamboo Shoot

To measure the height of an object was a new skill for children. Using a ruler had not yet been taught, therefore, children's actions and trials revealed their attempts at problem solving and their progress with measuring concepts.

Phase 1: Illustrate with Hands. In the measuring activity, children first used their hands to illustrate the height of a bamboo shoot found on the campus. However, the result did not satisfy them.

Two children suggested using hands, while another child found a problem with this.

C7: "His hands are a different height from hers."

(Field note, 2008.04.22)

Then everyone realized it was difficult to illustrate the height with hands since

they failed to keep their hands still.

Phase 2: Measure with String. One child suddenly came up with the idea of using a piece of string to measure the branch.

C3 stood the branch on the ground, letting C2 use a piece of string to measure it. One end of the string was at the same height as the branch; however, C2 simultaneously lifted up the other end of the string so she could not get the correct height.

T: "Are they the same height?"

C3: "We missed the bottom part. You should put the string on the ground."

When the bottom end of the string reached the ground, the upper end went down at the same time. After a discussion, C2 managed to loosen the string scroll and reached both ends of the branch.

C3: "We made it!"

(Field note, 2008.04.22)

The problem solving ability was observed in their interaction. When teachers opened an opportunity for free exploration, children could have a chance to perform inquiry behavior.

Phase 3: Compare the Difference. In order to understand how fast a bamboo shoot grew up, children learned to record the changes in height. They stuck strings on the wall, indicating the height of a bamboo shoot on different days, and were amazed to find that the growth was faster than they could imagine.

C3: "It's growing fast! It's probably taller than me!"

C13: "Last week I was taller than it, and this week it's taller than me."

C1: "We grow up slowly, and Ali grows up fast."

(Field note, 2008.04.30)

From the records marked on the wall, children realized bamboo was a fast-growing plant. This simple measurement activity helped to develop children's thinking ability and problem solving skills. Teachers set up the environment for children to actively experiment and experience consequently, scientific concepts of natural plants were progressively established.

Children Developed Concepts of Bamboo Nodes through Close Observation

Having developed basic scientific skills like measuring, children were able to go further and deeper as they explored the characteristics of the bamboo nodes. Teachers encouraged children to observe and touch the nodes on their own. After close observation, children started a comparison between the nodes of a bamboo tube and a bamboo shoot.

C8: "The length between two lines on a bamboo shoot is shorter than that on a bamboo."

T: "Why is it longer on a bamboo?"

C8: "Because the bamboo grows up."

C3: "Because ruma gets taller, but Grandpa pulled out the Ali when it didn't grow up yet."

(Field note, 2008.04.24)

T: "Are there branches on every node?"

A child holding the bamboo found that there were no branches on the bottom part of the bamboo. Moreover, children also found that there were two branches on each node.

(Field note, 2008.04.25)

After a week's exploration, children acquired concepts of the bamboo nodes and

realized that the nodes were the origin of new branches. From the external appearance to the internalization process, children learned to infer their findings from past experiences.

Children Acquired Knowledge of Rhizomes by Exploring their Natural Surroundings

As one of the significant characteristics of bamboo, the node was easier to observe than another important part—the bamboo rhizome. Since bamboo rhizomes usually go underground, they were more difficult to understand. However, children in this research were lucky to have rich learning resources, since the bamboo forest was just beside their campus. Hence, children were aided by Nature to begin their scientific inquiry into bamboo rhizomes.

Rhizomes as the Origin of a Bamboo Shoot. One of the most important characteristics of bamboo rhizomes is its connection between the bamboos and bamboo shoots. Teachers started a discussion to reveal “the secret of the bamboo’s birth” while children performed creative thinking and expression.

T: “Why did the rhizome come out?”

C4: “It came out to see the bamboo.”

C8: “To see how tall her son is”

C7: “The rhizome is to see the child!”

(Field note, 2008.05.20)

When children explored the surrounding bamboo forest, they had a better chance to observe bamboo rhizomes more closely. With the observation experiences in Nature, children acquired better understanding of a bamboo’s cycle. A clear and reasonable statement was made:

C12: “Ali is connected to a rhizome, and the rhizome is from the bamboo. A

rhizome has many nodes, and that's where an Ali comes from.”

C2: “When Ali grows up, it will become a tall ruma.”

(Field note, 2008.05.21)

Although knowledge of bamboo rhizomes was not familiar to children before the curriculum, the active inquiry process and close observation in the natural environment did help children to successfully work out the relation between bamboo, bamboo shoots, and rhizomes.

How It Goes Underground. After the implementation of deep inquiry and exploration, children became more sensitive to their surroundings. When they went to the playground, children noticed that there were some rhizomes revealed.

C5: “Under sunshine, it's green.”

C3: “Without sunshine, the rhizome underground is yellow”

C2: “The rhizome is hard. It walks underground.”

C8: “Right! If it's soft, it will not be able to grasp the soil, and thus it can not walk.”

(Field note, 2008.05.22)

From their very wise and vivid description, we see how children's internal thinking process worked. By means of the project curriculum and active inquiry practice, children in this kindergarten built up science-related concepts and knowledge about natural plants from the precious environment.

Part III: Teachers' Educational Reflections on the Project Implementation

After the implementation process of constructivist inquiry-based teaching, teachers' introspection strengthened the value of the project curriculum. Based on their reflections, some major concerns are discussed as below.

Learning from the Environment was Beneficial to Both Children and Teachers

Though it was quite easy for children to see bamboos/bamboo shoots in their daily lives, the understanding of the bamboo remained mainly at the visual level. Therefore, teachers based children's learning on their existing experiences, and attempted to conduct further exploration into the environment collaboratively with children.

"We chose the topic—the origin of a bamboo and a bamboo shoot—to be our inquiry issue. Looking into the environment to find out the answer was a great learning and teaching motivation."

(Teacher's reflection, 2008.04.21)

When reflecting on what children said, teachers were impressed by their advancing progress, especially the responsive reactions and active way of approaching the nature.

"After a few weeks' experience, I'm deeply touched by children's concrete response and interpretation. This is the best achievement we've ever had in this year. I'm really delighted to see it."

"It's amazing to realize that children are so familiar with the bamboo, and can internalize their findings in outdoor experiencing to establish conceptual knowledge. I appreciate Nature for giving us the vigorous land, so that we can probe into the secret of lives."

(Teacher's reflection, 2008.05.21)

The connection between natural bamboo and Tayal people's life was the key to the success of children's concept development. Only when teachers realized this could they make a better conjunction between school and community. The bamboo

project not only brought children a great opportunity to know nature, but also inspired the teachers to make good utilization of local ecological resources as teaching materials.

Teacher as the Co-learner, not the Instructor

Learning from local ecological resources, the project theme was also new to the teachers. The implementation of the project curriculum was a co-constructing process for teachers. Being the co-learners, instead of instructors, the teachers acquired ecological science knowledge together with their children in the research.

“Not only the children were surprised by the fast growing speed of the bamboo shoot, but also we were amazed to know that, it was really astonishing how fast a bamboo shoot could grow.”

(Teacher’s reflection, 2008.04.30)

From the personal experience, the teacher actually realized the importance of using natural materials as learning resources when she learned from Nature as well. Sometimes children are better observers than adults. In this project, children helped teachers to explore more detailed and interesting things.

“It was so great to see the bamboo rhizomes came out of the ground. Children were more sensitive to the little things than us. We observed the rhizomes together, and it was also my first time to realize that rhizomes had the same nodes as the bamboos did.”

(Teacher’s reflection, 2008.05.20)

In the traditional teaching-learning hierarchy, teachers are instructors who provide information while children don’t have enough opportunities to become actively

involved in their knowledge construction process. In this constructivist inquiry-based project curriculum, teachers and children were co-learners in their exploration of the surrounding Nature. Thanks to children's creativity and sensitivity, teachers were inspired by their remarkable achievement.

Teachers Should Encourage Active Involvement in Children's Inquiry Process

Though teachers were expecting children's conceptual development in the science project curriculum, they should leave autonomy to children in the inquiry process. Constructivist teaching roles include teacher as presenter, observer, question asker and problem poser (Chaille & Britain, 1991). In this research, teachers used to start an activity with a question, and let children begin their own problem solving process. Self-initiated inquiry was encouraged and most valued.

"I'm always thinking: 'Can I throw a better question out? Can the question lead children to a flourishing discussion?' From their focusing on one issue and trying to figure out the answer, we know that the thinking ability is being developed."

(Teacher's reflection, 2008.04.24)

When teachers continuously introspected and self-examined, they saw the real problem and made adequate pedagogical modification.

"I was expecting that children could figure out the answer after their observation. But their viewpoints were different from teachers'. So the better solution was to let children explore in their own way. When they had the practical experience, they could understand and respond correctly."

(Teacher's reflection, 2008.04.25)

"Supposing that children could make a cognitive progression after one or two

trials was a dangerous myth. The superficial or temporary memory was easily erased. The important task for teachers was to provide a chance for children to fulfill a complete process of scientific inquiry.”

(Teacher’s reflection, 2008.05.22)

According to the constructivist approach, teachers should act as facilitators in children’s scientific inquiry process. What matters in science teaching is children’s active learning. From teachers’ reflections, we could see the importance was well captured. Especially when the learning topic was about children’s real-life experiences, keeping children in an unrestrained environment could make the curriculum respond more closely to their culture. During the whole process of implementing the inquiry-based science project curriculum, teachers realized children’s active involvement was crucial to the achievement of the project’s goals.

Conclusion

Not only the children, but also the teachers benefited from the co-constructing process of the inquiry-based science project curriculum implementing place-based education in the Tayal indigenous tribe. The conclusions of our research are as follows.

1. Teachers and children managed to co-construct a science project curriculum based on local resources and Tayal traditional knowledge.

Bamboo is closely related to Tayal people’s daily lives. To use bamboo as learning material enabled children to connect the school curriculum with their life experiences. Nature as a big classroom provided rich environmental resources in the science project curriculum. In addition, tribal knowledge from community members also assisted children’s understanding of the bamboo. Moreover, the practical experience of making steamed rice in a bamboo tube introduced children and teachers to the

traditional wisdom of Tayal culture.

2. Children developed basic scientific concepts and knowledge about natural plants through the inquiry-based project curriculum.

With teachers' implementation of a constructivist inquiry-based teaching approach, children were encouraged to construct their own scientific concepts and knowledge about natural plants. Basic scientific concepts like measuring skills were developed in children's problem solving process. After close observation and group discussion, children acquired knowledge about bamboo nodes and rhizomes. When there were more opportunities for children to freely and actively explore their environment, children could raise their learning motivation and achieve remarkable success in the science inquiry activities.

3. Teachers regarded their roles as being co-learners with children and realized the importance of children's active involvement in the constructivist inquiry-based teaching.

Being co-learners with children, teachers also acquired new knowledge about natural plants by learning from the environment. Furthermore, children's fine observation ability and creativity amazed teachers and strengthened their confidence in practicing constructivist inquiry-based teaching. Above all, teachers realized the crucial importance of cultural resources and children's active involvement in the inquiry-based project curriculum, and could improve their pedagogy according to children's participation and performance.

The result tells a similar story to other research studies done within different indigenous communities all around the world (Chi & Liu, 2000; Fu, 2004; Glasson, Frykholm, Mhango & Phiri, 2006; Hipwell, 2009; Riggs, Robbins & Darner, 2007; Shizha, 2007; Thomson, 2003), that is, to respect and respond to cultural knowledge and local resources may benefit indigenous students' learning. However, paying

special attention to a particular tribe (e.g. Tayal people), helps educators develop a more adequate and suitable curriculum for the tribal children. In this study, knowledge about natural plants (bamboos in particular) and Tayal traditional wisdom about bamboo usage had added value to the science project curriculum. Therefore, from their participation in the research, early childhood teachers and Tayal young children managed to realize and practice the essentials of culturally responsive schooling. Moreover, the researcher obtained stronger evidence as to how place-based teaching could benefit indigenous children's learning through constructivist inquiry activities. In conclusion, the achievements in the constructivist inquiry-based science project curriculum successfully conformed to the perspectives of place-based education: learning from the environment helped to connect school education with children's real life experiences. With the knowledge acquired through active inquiry, as well as the utilization of both traditional and local resources, the Tayal indigenous young children were surely promised a flourishing educational environment.

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