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Collaborative Action Research on the Implementation of a Science Thematic Curriculum for Young Children

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Abstract

Using collaborative action research, this study aimed to explore the practice of implementing a science integrated curriculum in a kindergarten classroom in Taiwan. The author served as a curriculum consultant, and two kindergarten teachers served as co-teachers. The participants were 30 young children. Data sources included classroom observations, interviews, and other documentation. The findings were as follows. (1) The science thematic curriculum was developed from the young children's interest in bats. The kindergarten teachers applied the science thematic approach to integrate science and other content areas in the thematic curriculum focused on the science theme "Bats." (2) The young children learned about the science concepts of bats' characteristics, habits, and habitats, as well as the cultural meaning of bats in the local culture. (3) The kindergarten teachers had to solve problems in science teaching, such as problems related to the children's observation of bats and teachers' content knowledge in science teaching. This study provides us a lens to examine how early childhood teachers implemented a science thematic curriculum in a kindergarten classroom. Recommendations for science teaching in early childhood education are also discussed in the paper.

Keywords: integrated curriculum, science thematic approach, early childhood science teaching

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Introduction

For a long time, early childhood science education was underemphasized in preschools and kindergartens in Taiwan (Chang, Huang, & Shieh; Lin, 2008; Shin, 1999). Early childhood teachers do not teach much science to young children. Some are afraid that they do not have enough knowledge to provide young children with appropriate scientific knowledge (Lin, 2001; Lin, 2008). Since early childhood teachers often feel uncomfortable teaching science, researchers have proposed integrating science into other content areas (Garbett, 2003; Trundle & Sackes, 2012).

Integrated curriculum is a popular curriculum design in early childhood settings (Pawilen, Arre, & Lindo, 2010). It supports the idea of learning from real life, cutting across subject-matter lines, and utilizing themes to organize contents and activities. Although most Taiwanese early childhood teachers do not feel confident in their ability to teach science, they can implement a thematic curriculum that integrates science and other content areas. The science integrated curricula can benefit young children's learning in science, problem solving, or language development (French, 2004; Hsu, 2011; Liu, 2005).

Action research is concerned with social practice, initiated to solve problems, and aims toward improvement in a reflective process (Kember, 2000). Collaborative action research involves more than one research member on a research team (Chen, 1998). In order to help the kindergarten teachers to improve science teaching and to benefit young children's learning in science, I applied collaborative action research and guided the kindergarten teachers to integrate different content areas into an integrated curriculum focused on the selected science theme. Because of young children's encounter with bats and their interest in bats, the theme of bats was selected in the science thematic curriculum. Using collaborative action research, this study aimed to collaborate with the kindergarten teachers and explore the practice of implementing a science integrated curriculum focused on the theme Bats in the kindergarten classroom. This study will provide us a lens to examine how early childhood teachers implemented a science thematic curriculum in a kindergarten classroom. Based on the aim of research above, the research questions are as follows.

1. How did the teachers develop the science thematic curriculum?
2. How did the young children demonstrate their science concepts of bats?

3. What challenges did the teachers encounter in their science teaching? How did they solve the problems?

Literature Review

Curriculum Integration

The origin of curriculum integration is found in the philosophy of progressive education that flourished at the beginning of twentieth century. The emphasis of the progressive movement on child-centered curriculum and holistic learning promoted the idea of integration between curricular disciplines. It supports the idea of learning from real life rather than separated-subject and textbook-dominated school curricula.

The product of curriculum integration is integrated curricula. Shoemaker (1989) defines integrated curricula as "cutting across subject-matter lines, bringing together various aspects of the curriculum into meaningful association to focus upon broad areas of study" (p. 5). Erikson (2001) defines integrated curricula as different disciplines sharing a common conceptual focus, which utilizes themes for organizing contents and activities. Generally speaking, an integrated curriculum usually begins with a unifying theme—a question, name of a place or object, problems and issues, or projects that might interest both teachers and students (Pawilen, Arre, & Lindo, 2010).

There are various approaches used for integrating the curriculum in early childhood classrooms, such as project approach and thematic approach (Gestwicki, 2010). According to Katz and Chard (2000), a project is to study a real-world topic with in-depth investigation, which is worthy of children's attention and efforts. The project approach also integrates content knowledge and skills from various disciplines, so that children can learn to make cross-curricular connections. The thematic approach is developed through the process of webbing and integrating all subject areas under one theme. According to Chou (2006), a theme develops important concepts and various activities in different content areas, such as language, science, math, art, music, social studies, and so on. Thus, a theme serves as an important role in the source of contents and activities in planning an integrated curriculum

(Pawilen, Arre, & Lindo, 2010).

Science Integration Curriculum for Young Children

Since early childhood teachers may feel uncomfortable teaching science, researchers suggest integrating science with other content areas for young children (Garbett, 2003; Trundle & Sackes, 2012). Specifically, some researchers suggest integrating science and math because they both involve similar cognitive skills. Others suggest integrating science and literacy because children's literature can be used as a tool to develop science concepts and inquiry skills. In addition, science can be integrated with other content areas in an integrated curriculum. Below, I discuss examples of integrated curricula that focus on science topics for young children.

Stegelin (2003) proposed applying the Reggio Emilia approach to the early childhood science curriculum. He provided an example of curriculum for an in-depth project on rainforests for second-grade students. The curriculum implementation consisted of three steps. (1) Emergent curriculum: The teacher identified and recorded topics that seemed to interest the children. (2) Selecting the topic: The teacher chose the topic "Rainforests," which interested the children and fit the Science Benchmark Content Standards for K-3. (3) The teacher identified key questions for the rain forest project: "What do you already know about rainforests? What do you want to know about rainforests? What did you learn about rainforests (Stegelin, 2003, p.167)?" In the process, the teacher learned about the children's prior experiences related to the topic. She selected materials and organized activities and fieldtrips. The project integrated art activities, language, literacy, hands-on activities, and documentation efforts. Finally, the children reflected on what they had learned from the project.

Baldwin, Adams, and Kelly (2009) developed the *Science Concept Planner* to support an emergent, standards-based, and child-centerd curriculum. Teachers began with a science topic that interested the children and identified reference materials on the related concepts. They further developed an anticipatory planning web with important science concepts and activities. For example, the topic "Frogs" included concepts about amphibians, habitats, life cycle, and habits. Activities for the concept of habitats consisted of visiting a pond, designing a frog's

home, and building a pond. Furthermore, the teachers identified the content standards of different learning areas to support the topic and concepts. The questions the children raised could also be explored in the curriculum.

Chou (2009) proposed a science thematic approach to develop a science thematic curriculum by using a theme to organize science concepts and activities. For example, under the theme of "Animals," the science concepts consisted of genera and characteristics, ways of moving, food, living environment, breeding, growth, and benefit/harm to human beings. Furthermore, teachers organized various activities to help young children learn about these science concepts. The activities could be related to science, art, music and movement, language, etc.

In addition to the curriculum design methods above, some empirical studies discussed integrated curricula on science topics for young children. For example, Liu (2005) applied collaborative action research to study a science thematic curriculum in a kindergarten class in Taiwan. The thematic curriculum integrated science and other content areas taught in the kindergarten. It consisted of six topics—"I, Light and Shadow, Music Empire, Dancing Dragon and Lion, Seeds, and Insects in Kindergarten." Hsu (2011) used case study methods to study the implementation of a thematic curriculum on the topic "Science is Fun" in her kindergarten class in Taiwan. She applied the thematic approach (Chou, 2006) and Gardner's multiple intelligences (Cheng, 2008) to design the science thematic curriculum. The topic consisted of four units about wind, fire, light and shadow, and water. The results of both studies showed that children enhanced their abilities in science learning and problem solving and teachers improved their profession in science teaching.

The ScienceStart! Curriculum is also an integrated curriculum for young children (French, Conezio, & Boynton, 2000; ScienceStart, 2014). It organizes science as the center and integrates math, literacy, social studies, and art. It is designed to support children's language development, problem solving, social interaction, and self-regulation. The curriculum consists of five modules: measurement and mapping, color and light, properties of matter, neighborhood habitats, and movement and machines. In French's study (2004), she found that young children in ScienceStart! classes showed positively significant gains on the Peabody Picture Vocabulary Test, an instrument to assess young children's cognitive and linguistic level. Therefore, this program could prepare young children for academic success.

As shown above, some science integrated curricula focus on studying a science topic in-depth and developing young children's scientific ability (e.g., Baldwin et al., 2009; Chou, 2009; Stegelin, 2003). In this way, other learning contents serve assistant roles to help young children learn about science concepts. However, some science integrated curricula, such as the ScienceStart! Curriculum, emphasize holistic learning and developing young children's abilities in different learning areas—language development, problem solving, etc. (e.g., French et al., 2000). Some empirical studies also showed that integrated curricula on science topics benefit young children's learning in science, problem solving, or language development (French, 2004; Hsu, 2011; Liu, 2005).

Most early childhood teachers in Taiwan are familiar with the idea of integrated curricula and thematic approach. Both Liu (2005) and Hsu (2011) conducted their studies on the integrated curricula on science topics. While Hsu provided a clear thematic curriculum web and demonstrated how she applied the thematic approach and integrated the eight intelligences[2] in her kindergarten class, Liu did not provide a thematic curriculum web of how she developed the science thematic curriculum under six topics. Chou's science thematic approach (Chou, 2009) provides a clear guidance for teachers to organize science concepts and activities in a science thematic curriculum; however, Chou did not show an empirical study on the application of science thematic approach in early childhood settings. Because Chou's science thematic approach (Chou, 2009) provides a clear guidance in curriculum design, the kindergarten teachers and I decided to apply this approach to implement a thematic curriculum focused on a science theme in the classroom.

Methodology

Action research is research that is initiated to solve problems or a reflective process of problem solving. Collaborative action research involves more than one researcher on the research team (Chen, 1998). In this study, I applied collaborative action research methods and collaborated with the kindergarten teachers. I served as a curriculum consultant, and one main

[2] The eight intelligences were language, logical–mathematical, bodily–kinesthetic, musical-rhythmic, visual-spatial, interpersonal, intrapersonal, and naturalistic.

kindergarten teacher and one substitute teacher served as the co-teachers. The participants were 30 young children. The research design is as follows.

Sites and Participants

Sun Elementary School Applied Kindergarten (pseudonym) was established in 2001. It is located in Beigang Town in Yulin County, Taiwan. The town is famous for its temple, traditional architecture such as Chai-Tian Temple and old streets, and food such as wedding cakes and sesame oil. Every year, various groups make pilgrimages to Chai-Tian Temple as a practice of their folk beliefs in the goddess, Matzu. Because of the rich cultural resources in the town, the kindergarten children have opportunities to learn about the local culture.

There were two classes, a five-year-old class and a four-year-old class, in the kindergarten. The participants were 30 young children, 13 boys and 17 girls, in the five-year-old class.

Research Team Members

I served as a curriculum consultant, and the two kindergarten teachers, Ms. Lin and Ms. Cheng, served as the co-teachers. Ms. Lin, the main teacher, was at her age of 40s. She got her Master degree in early childhood education and had 20 years of teaching experience in the kindergarten. Ms. Cheng, the substitute teacher, was at her age of 20s. It was her first year of teaching and assisted Ms. Lin's teaching in the kindergarten.

As a teacher educator at the department of early childhood education in a university, I provided kindergarten teachers with advice on curriculum design and implementation. I observed their teaching in class and discussed the thematic curriculum web, curriculum content, and problems with them. The kindergarten teachers reflected on their teaching, planned and modified the learning activities, and prepared for the teaching materials every week. The action research cycle of planning, action, observing, and reflecting was employed.

Data Collection

This study was conducted over a five-month-period in the first semester of the academic

year of 2011 (from mid-September 2011 to mid-February 2012). Data sources included (a) semi-structured and open-ended interviews: formal interviews with the teachers for two hours (twice) and short interviews with the children (once); (b) participant observations of classroom activities (15 times); (c) notes on curriculum discussion meetings (three times); (d) class weeklies for 20 weeks, including the main curriculum implementation records; (e) teachers' weekly reflection notes for 20 weeks; (f) informal conversation with the teachers; (g) students' artwork and portfolios, such as children's drawings, art products, handmade books, and worksheets. The observations were videotaped, and the formal interviews were recorded and transcribed.

Data Analysis

I analyzed the qualitative data by coding and categorizing. Some issues emerged in the process, such as the difficulty of observing the bats, the cultural meaning of bats, etc. Additionally, I analyzed the content of children's drawings on the bats and their short interviews regarding their drawings in accordance with the science concepts in the science thematic curriculum. Different methods of data triangulation were used (Denzin, 1984), including methodological triangulation (e.g., observation and interviews) and data source triangulation (e.g., observation records, interview transcripts, reflection notes, and children's artwork). The kindergarten teachers were invited to do member checking, such as checking the Chinese/English interview transcripts. All the participants' names are pseudonyms. In addition, one Taiwanese professor of science education checked the English translation, examined the research results, and provided comments on the report.

Findings

The Development of a Science Thematic Curriculum

The science thematic curriculum was developed from the young children's interest in bats. They encountered with a bat in their classroom and showed their curiosity about it. As Ms.

Lin recorded,

> We got a new guest, a bat, this week. The children were very curious about it. To satisfy the children, we guided them to observe the bat in the window. The children raised lots of questions. "What's that?" "A beetle?" "A mouse?" "A bat?" "Is he sleeping there?" "What is he doing there?" "Does he live there?" (Weekly 5, 09/30/2011)

Ms. Lin and Ms. Cheng expected the young children to be active learners and to utilize the local resources in curriculum implementation. Since the young children had high interest in the bat, the two teachers decided to lead them to explore the world of bats in the thematic curriculum.

As a curriculum consultant, I guided the teachers to apply Chou's idea of the science thematic approach (Chou, 2009) and design the thematic web. The theme was used to organize the science concepts and activities in various learning areas. In the beginning of the curriculum design, we created our teachers' thematic web. In the process of curriculum implementation, more activities were suggested by the teachers and children. However, Ms. Lin was not familiar with the way to connect the science concepts with the activities in the beginning of curriculum design. It was because she used to design the activity web by organizing activities in different learning areas under one theme, and ignored the importance of concepts in a thematic curriculum. Through the discussion, Ms. Lin found that the concept played an important role to examine the learning activities.

> Researcher: Could you compare the difference between the concept web and the activity web when you implement a thematic curriculum? Which one is more helpful to you in the curriculum implementation?
>
> Ms. Lin: I think the concept web is new to me. I am more familiar with the activity web… But the concept web can help me examine the main idea of activities, and check what concept I ignored… (Interview I, 11/18/2011)

Overall, there were four science concepts and 23 learning activities in the thematic curriculum web (Figure 1). The science concepts consisted of characteristics, habits, living environment, and relationships with human beings. Each concept related to different learning activities. For example, in teaching the concept of a living environment, the teachers guided

the children to observe bats in a tree on campus, which is related to science. They also visited the Formosa Golden Bat's Home, which is related to science. The children then created small books about their visit to Formosa Golden Bat's Home, which is related to language.

The learning areas of science, language, visual arts, music and movement, drama, and social studies were integrated into the science thematic curriculum. The integrated learning areas helped the children to learn about the topic and science concepts. Because the teachers' specialty was art, many artistic activities were integrated into the curriculum, such as paper clay and paper cutting of bats. At the end of the curriculum implementation, the students staged the drama performance "Hsin-Yue," a story about a bat, and invited their parents to participate in the performance.

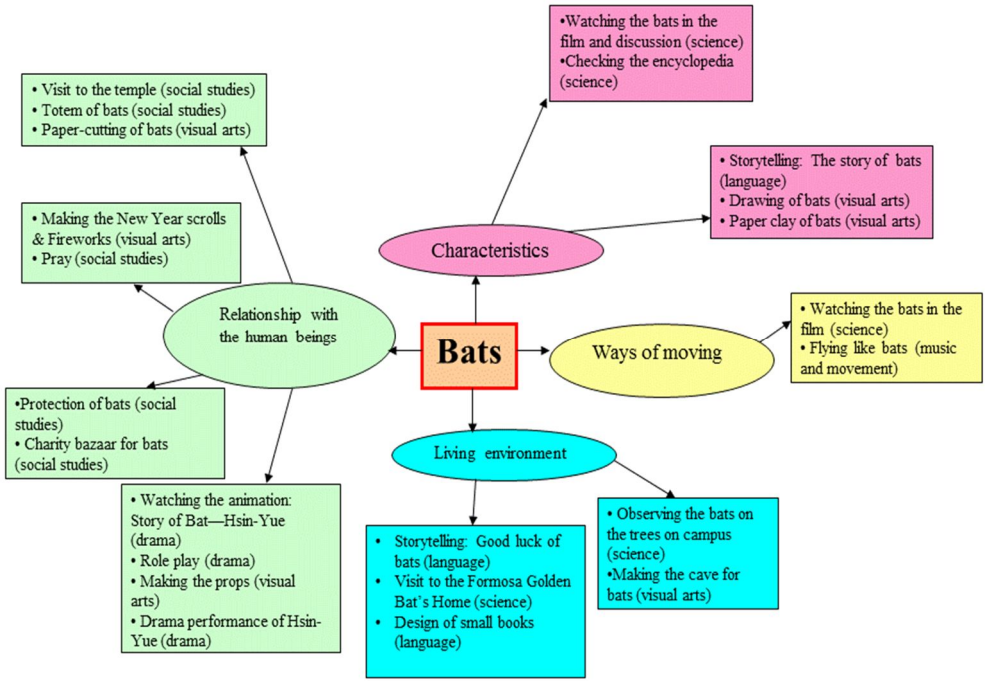

Figure 1. Thematic Curriculum Web

Young Children's Concepts of Bats

The young children learned about the science concepts of bats' characteristics, habits, habitats, and relationship with human beings, including the cultural meaning of bats in the

local area. They showed their understanding of bats in different ways. I discuss their concepts of bats as follows.

Science concepts of bats. Ms. Lin found that the young children showed their concepts of bats in different forms. For example, in regard to the concept of habits, the children showed how bats move in the role play. They imitated the behavior of bats hanging on a tree upside-down. Also, the children knew that bats are nocturnal; therefore, when they drew bats, they showed the background with dark colors. As Ms. Lin mentioned,

> I think the children know about the habit, out-looking, and ecology… They know that a bat hangs upside-down. So, they tried to hang on the tree upside-down when they acted the bats in the role play… And then, when making small books, they drew darker colors in the background. It is because they noticed that a bat is active at dark night. (Interview I, 11/18/2011)

Some children depicted a bat's ultrasonic waves in their drawings. For example, Ping described her drawing (Figure 2) by saying, "I saw a bat roaring. He made ultrasonic waves" (Interview with Ping, 10/28/2011).

Figure 2. Ping's Drawing

Shaio-Wen, a girl, drew a blue bat (Figure 3) and said, "*The blue bat hurries and flies. His eyes cannot see things clearly. He has to use the ultrasonic waves*" (Interview with Shaio-Wen, 10/28/2011). Both children showed their understanding of bats' use of ultrasonic waves. While Ping explained how a bat uses ultrasonic waves, Shaio-Wen explained why.

Figure 3. Shaio-Wen's Drawing

Figure 4. Shaio-Bu's Drawing

In regard to the concept of characteristics, the young children learned that bats have rounded eyes, sharp ears, sharp claws, and black wings. They also have special features. For example, Shaio-Bu shared his drawing (Figure 4) by saying, "*This bat has a nose that looks like a pig's nose. So it is called a hog-nosed bat*" (Interview with Shaio-Bu, 10/28/2011).

Regarding the concept of habitat, the young children learned that bats live in caves, trees, or homes. They also noticed that bats hide in dark and quiet places. Ms. Lin had a further discussion with the children after reading the picture book about bats.

Teacher: Do you know where the bats live?

Students: Cave. (All the children answered together.)

Teacher: In addition to the cave, do you know where other bats live?

Ming: Some bats live at home.

Teacher: Do you mean they live at our houses?

Ming: Yes.

Chin: Maybe he feeds the bats.

Teacher: Yes, maybe. In addition to the caves and houses, what answer do you have?

Yun: Outside.

Teacher: Where is it?

(Yun had no answer.)

Teacher: Who knows where the bats live?

Wei: Trees.

Teacher: Yes, great… Do you know where the bat hides itself?

Students: Darker place.

Students: Quieter place.

Su: A place nobody can find it.

(Observation 4, 10/07/2011)

Connecting the bat with its cultural meaning. As for the relationship of bats with human beings, the young children learned that bats are a great benefit to people in Taiwan. For example, a bat's excrements can be used to make Chinese medicine. Bats can eat harmful insects. Additionally, the bat represents good luck in the Chinese culture and local culture.

Ms. Lin introduced the cultural meaning of bats to the children. The Chinese word for "bat"

is *bian-fu* (蝙蝠). *Fu* (蝠) implies "good luck" (福). She guided them to observe the symbol of bats in the Chinese New Year scrolls. The children further created their scrolls with figures of bats (Figure 5). Some of them even wrote "You have good luck" on the scrolls.

Figure 5. Children's Artwork of Chinese New Year Scrolls

Figure 6. Golden Bats in the Wooden Sculpture on the Beam

Ms. Lin and Ms. Cheng also guided the children to look for figures of bats in Chai-Tian Temple. The children found figures of bats on the stone sculpture on the wall, wooden sculpture on the beam, and embroidery on the table (Figure 6). They shared what they learned

and their interest in the figures of bats on worksheets.

Yoyo: I saw the golden bats in the temple.

Hsin: The bats on the stone sculpture are so cute.

Jean: I found many interesting things about the good luck of bats in the temple. I'll look for other things next time.

(Worksheets, 01/04/2012)

Challenges and Problem Solving in Science Teaching

The kindergarten teachers faced the challenges and tried to solve problems in their science teaching, such as problems related to the children's observation of bats, and teachers' content knowledge in science teaching. I discuss these issues as follows.

Observation of bats. Because the children could not observe bats regularly during the day, they mostly learned about bats from second-hand experience, including reading picture books, looking at pictures in the encyclopedia, searching the internet, and watching films. For example, Ms. Lin and Ms. Cheng collected the pictures of bats and showed the pictures in PowerPoint slides. The children observed the characteristics of different genera of bats and compared their appearances. Furthermore, they made bat artwork using paper clay. The teachers explained,

Because we cannot see the bat at day time regularly, we teachers looked for the pictures of different bats in Taiwan. In this way, the children can observe different bats' characteristics. They found that different bats have different shapes of ears. They also have different appearances… After that, the children were invited to make the artwork of bats with paper clay. (Weekly 5, 11/04/2011)

The young children only saw the bats twice in their classroom. To provide more opportunities to observe the bats, the teachers brought the children to look for bats in a tree on campus. They further took the children to visit the Formosa Golden Bat's Home in the neighborhood. The children listened to the guide's introduction to bats, observed the bat specimens, and found bats living in many small houses. However, it was difficult for them to observe the bats moving because the bats were sleepy during the day. In spite of this, the

children filled out the worksheets as a record of what they observed during the visit. Ms. Lin mentioned,

> We took the bus to the Formosa Golden Bat's Home. With the parents' assistance, the children were divided into several groups and explored the world of bats… To help the children to integrate their ideas and record their reflection from the visit, we assigned the worksheets as their homework. (Reflection 9, 10/28/2011)

Content knowledge in science teaching. Ms. Lin believed that early childhood teachers are weak in science. To her, it was also a great challenge and pressure to teach science. This was her first time leading her students in studying a science thematic curriculum in depth. She was afraid that she did not have enough scientific knowledge and might mislead the children in their science learning. She was also afraid that she would not be able to respond to the children's questions.

> It was my first time teaching science in depth. I think early childhood teachers are weak in science… Actually, it is a big challenge to me. Because there is a right answer… If you say something wrong, it may mislead the children. To avoid the wrong information, you have to prepare for the lessons carefully… (Interview II, 02/15/2012)

In order to help Ms. Lin, I provided the books, encyclopedia, and documentary films about bats. Through our curriculum discussion and curriculum implementation, Ms. Lin improved her content knowledge for science teaching. She also studied the bats to be able to respond to the children's questions. As she said, "I have to study something, so that I can have the ability to provide answers to young children" (Interview I, 11/18/2011).

However, Ms. Lin considered that early childhood teachers do not have to talk about a wide range of scientific knowledge to young children, as the young children might lose their interest in science learning if they cannot understand the scientific terminology and phenomena. In her teaching, she taught simple science concepts first. She also invited the children to create artwork or role play about the bats to help them understand that bats are living creatures in their lives. She explained,

> I think it may be too professional to talk about lots of science. The young children may lose their interest if they cannot understand it. So… we teach children about the ecology,

> living environment of bats… I think it's enough to let the children know about some simple concepts. And then we invite them to do something, such as art activities or role play… It will help the children feel that the bat is a living creature in their life. It's not only about the science terminology… (Interview I, 11/18/2011)

Nevertheless, Ms. Lin believed that it is important for early childhood teachers to improve the knowledge in science education by attending workshops in science education, reading books about science, and visiting science museums, etc. For her, it is also important to teach science concepts to children using language the children understand.

Discussion

Bruner (1996) points out, "learning and thinking are always *situated* in a cultural setting and always dependent upon the utilization of cultural resources" (p. 4). In this study, a science thematic curriculum was developed based on young children's encounter with bats and their interest in bats. They learned about bats in real life and utilizing local resources. They also learned about the cultural meaning of bats in the local culture. Here I discussed some issues in response to the three research questions.

First, the kindergarten teachers applied the thematic approach to design the science thematic curriculum, which integrated the learning areas of science, language, visual arts, music and movement, drama, and social studies. The integrated learning areas helped the young children learn about the topic and science concepts. However, in early childhood science education, it is important to develop young children's scientific procedural ability, including observation, reasoning, prediction/experiment, and communication (Chou, 2009). The new *Curriculum Guidelines in Early Childhood Education and Care* (Ministry of Education, 2012) also emphasize developing young children's ability in collecting information, including observation, measurement, and records. Yet the young children in this study had few opportunities to observe bats directly. Thus, it was hard for them to do scientific prediction and experiments.

Science is incorporated in the Cognition Domain in the new *Curriculum Guidelines in*

Early Childhood Education and Care (Ministry of Education, 2012), which aims to develop young children's cognitive ability for collecting the information, arranging the information, and solving problems. It is suggested that kindergarten teachers design a thematic curriculum and learning assessment according to the curriculum goals and learning indicators in the new curriculum guidelines. This idea is similar to linking the Science Benchmark Content Standards in curriculum design and assessment (Stegelin, 2003). Baldwin et al. (2009) also suggested integrating all content standards to support the topic and concepts in a thematic curriculum and authentic assessment. Content standards can provide teachers with guidance in curriculum planning and assessment.

Second, the young children learned about the science concepts of bats' characteristics, habits, habitats, as well as the cultural meaning of bats in the local culture. They showed their understanding of bats in different formats, such as drawing, moving, and discussing. In their drawings, the children showed the characteristics of bats and bats' use of ultrasonic waves. Research has shown that young children's drawings convey their science conceptual understanding at different levels (Chang, 2011, 2012). Their drawings can play the role of assessment, teaching and learning, and communication of ideas with adults.

Third, the kindergarten teachers had to solve problems in their teaching, such as problems related to children's observation of bats, and teachers' content knowledge in science teaching. Because it was not easy to find a bat during the day, the teachers had to provide different ways for young children to observe bats. For example, they provided opportunities for young children to observe the bats from the second-hand experience, including the encyclopedia and films. They also brought the children to look for bats on campus and to visit the Formosa Golden Bat's Home once. However, the children's first-hand experience of observing the bats was not enough. It is suggested that kindergarten teachers collaborate with the ecological conservationists in the Formosa Golden Bat's Home. The children can interview the conservationist to learn how they feed the bat and how they study it. They can also visit the field more often to make more observations.

Although the kindergarten teachers lacked confidence in science teaching, they still tried their best to lead the young children to study bats in the thematic curriculum. In her reflection, Ms. Lin indicated that she improved her professional knowledge in science teaching. Some researchers, such as Hsu (2011) and Liu (2005), also found that kindergarten teachers

improved their practice of science teaching through implementing science thematic curricula in action research.

Conclusion and Recommendations

This study explored the implementation of a science thematic curriculum in a kindergarten classroom. The major findings were shown as follows. (1) The science thematic curriculum was developed from the young children's interest in the bat. The kindergarten teachers applied the thematic approach to integrate science, language, visual arts, music and movement, drama, and social studies in the science thematic curriculum. (2) The young children learned about the science concepts of bats' characteristics, habits, habitats, as well as the cultural meaning of bats in the local culture. They showed their understanding of bats with different ways, such as drawing, moving, and discussing. (3) The kindergarten teachers faced the challenges and had to solve certain problems in their science teaching. For example, it was not easy to find a bat during the day. The teachers had to use different ways for young children to observe bats. The teachers also had to improve their content knowledge in science teaching to help the young children to explore the world of bats.

This study provides us a lens to examine how kindergarten teachers implemented a science thematic curriculum in a kindergarten classroom in Taiwan. Early childhood teachers are encouraged to integrate science into the thematic curriculum. It is also important for teachers to guide young children to select a theme that they are interested, and to help young children learn science through life experience, utilize local resources, and even connect science with the local culture.

Some recommendations can be made for teachers' professional development and future research directions. First, in science teaching professional development, early childhood teachers are encouraged to improve their science education knowledge by reading books about science and young children, attending workshops in science education, and visiting science museums. They are further encouraged to design science activities according to the Cognition Domain in the *Curriculum Guidelines in Early Childhood Education and Care* (Ministry of Education, 2012). Second, this study did not provide enough information about

young children's science learning progression. It is suggested that future researchers apply clinical interviews and drawings, including pre-interviews and post-interviews, to investigate young children's learning progression in science concepts. Thirdly, this study investigated young children's science learning in a science thematic curriculum. To understand young children's holistic learning, it is suggested that future researchers explore related learning abilities, such as problem solving, language development, or social interaction, in an integrated curriculum.

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