

## Education for Environmental Sustainability in Preschool through STEM Project-based Learning

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### ABSTRACT

Educating preschool children on environmental sustainability is an excellent investment in shaping a sustainable society. In this study, the researchers conducted action research using Lilian Katz's Project Approach in cooperation with two teachers to explore the process of developing and implementing STEM modules in a preschool in Chengdu, China. Thirty children aged 5 to 6 years were involved in STEM modules in two cycles, each cycle was improved based on feedback from the previous cycle. Adopting the constructivist approach, these STEM modules are child-centered, inquiry-driven, and process-oriented. Through observation and interviews with teachers, children and principals, it was found that these STEM modules successfully engaged children to investigate, deepen their understanding of trees, motivate them to experiment and innovate, and enhance their self-learning ability. The children were happy and excited to learn, they expressed aspirations to create a green world, protect trees, and save and recycle paper. In short, they showed the beginning of understanding and awareness of environmental sustainability.

**Keywords:** Environmental awareness, STEM, Modules, Project Approach, Preschool, Action Research

### Introduction

In today's modern world, there has been an increasing concern for the prolific man-made environment that has caused problems such as depletion of natural resources, global warming, and declining biodiversity (Gunderson, 2014). Educating individuals with nature-loving attitudes and behaviors toward the sustainability of the environment is a crucial first step to solving these problems. Educational researchers suggested that effective implementation of environmental education promotes the formation of responsible attitudes and behaviors in individuals, which have long-lasting outcomes that will influence society and the world they live in (Cagle, 2018; Corraliza & Collado, 2019). To drive such

desired change in environmental behaviors, all individuals need to be equipped and empowered by their values and heightened awareness, knowledge, and skills to create a world that is more just, peaceful, and sustainable, as stated in the Rio+20 (UN Convention on Sustainable Development, Rio De Janeiro, 2012). The effort starting early childhood is a good investment to establish a long-term friendly relationship between humans and the environment, nurturing environmental sensitivity in young global citizens. It is well established that such positive relationships and environmental sensitivity in individuals should be developed within the scope of environmental education in early childhood (UNESCO, 1978). Education for environmental sustainability without a doubt needs to begin from a young age.

## Literature Review

Environmental problem is ascribed to the lost connection between humans and nature (Clayton, 2003; Mayer & Frantz, 2004; R. Wilson, 2007). Schultz (2002) emphasized that an increase in our bond (connection) with nature through engagement in activities using various kinds of natural elements and within the nature setting will help us to accumulate experiences that help achieve positive behavioural changes in our environmental awareness and sensitivity. This engagement needs to start young to widen the children's environmental perspectives and develop their emotional connection with nature and their interest in topics related to the environment. Researchers like Chawla and Cushing (2007) and Wells and Lekies (2006) agree that this is the purpose of education for environmental sustainability. Environmental sustainability is generally defined as the ability of our planet Earth to maintain an ecological balance in terms of its natural resources to support the well-being of current and future generations. Educating children in environmental sustainability is therefore of utmost importance for human survival as environmental degradation and climate change are increasingly harming the earth. According to Louv (2008), the limited time children spend in nature leads to weak ties (connection) with the environment, which, in turn, negatively impacts their development of sensitivity towards environmental sustainability.

Many studies have revealed that children may form responsible behaviors, positive attitudes, and environmental ethics once their affection and love for nature are nurtured in their early years of life (Fisman, 2005; Palmberg & Kuru, 2000). Thus, this call for environmental education in early childhood is urgently needed (Ernst & Burcak, 2019; Otto et al., 2019; Wals & Benavot, 2017). It is critical to strengthen and maintain this connection with nature in the early years, as it is only when these feelings embed themselves in the way children see the world that action for environmental sustainability take root especially when they become responsible adult (Kahn Jr. & Kellert, 2002; Tilbury, 1994; R. Wilson, 2007).

One of the most effective ways to implement children's environmental education programs is to design them in line with children's learning and development. This would help to develop their love of nature, increase their interaction and connection with nature and form a positive attitude. Many kinds of research have been conducted to study children's understanding of science concepts related to the environment. The main target

of these studies is the development of environmental education programs that could shape children's attitudes and behaviors positively toward the environment (Ergazaki & Andriotou, 2010; Littledyke, 2004; Palmer, 1995).

## Problem Statement

In China, preschools are mandated by the Ministry of Education to provide children with high-quality early childhood education programs. Many preschool education providers and teachers understood high quality as readiness for primary school, thus, they adopted a basic-skills-oriented approach in reading, writing, and arithmetic. This is despite the Ministry of Education's recommendation for a more child-centered approach that would enable children to have direct, open-ended, self-initiated experiences and focus on children's all-round development. This attention to academic preparation at the preschools meet parents' expectation and make children "win at the starting line". However, it makes it difficult for preschool teachers in China to incorporate experiences in natural outdoor settings despite the worldwide movement to reconnect children with nature. Thus, it is necessary to explore how to provide children with more learning opportunities in nature to develop their lifelong positive attitudes and values toward nature and subsequently inculcate awareness of environmental sustainability.

## Project Approach

Project Approach is a pedagogy that allows children to construct knowledge, participate, and exercise agency (Nelson, 2001). As an integral part of the Progressive Education Movement (notably John Dewey's work advocating the idea of "learning by doing"), the Project Approach developed in the 1910s allows the teacher to facilitate children's learning and development through project work, which is defined as an in-depth investigation of a real-life, worthwhile topic of their interest (Helm & Katz, 2016). The characteristics of the Project Approach are child-centered, inquiry-driven, process-oriented, and constructivist, all of which attune to children's innate dispositions, including their inborn curiosity about their surrounding environment and make sense of their experience (Helm & Katz, 2016; Katz, 1994).

In this study, the researchers and two preschool teachers cooperated to design project-based learning STEM modules targeted at promoting children's love for

nature. The Project Approach by Helm and Katz (2016) was employed to design and implement the designed modules.

**Aim and Research Questions**

This study aims to explore the use of the Project Approach in increasing children’s connection to their natural environment while promoting their love for nature. To this end, the research questions are:

1. How were the STEM modules formulated to generate awareness of environmental sustainability?
2. What are the challenges and barriers to designing and implementing STEM project-based learning modules in preschool?

**Methodology**

The research methodology adopted in this study is action research because it is thought to be one of the most appropriate ways to solve the issue of instilling a love of nature among young children. Action research is also focused on solving the problem by informing preschool teachers of new methods that can impact their teaching and learning. This section deliberated on the selection of the setting and participants, data collection, and data analysis.

**Setting of the Study and Participants**

The study was conducted in a public preschool in Chengdu, Sichuan Province, China. Participants included two (2) preschool teachers with over five (5) years of teaching experience and thirty students (30) aged between 5 to 6 years old. All the participating children’s parents provided written consent for their children’s participation. The two teachers espoused the value of the child-centeredness Project Approach and learned to implement it in this action research through the help of researchers. A

convenience sampling method was employed to select the participants. This method is appropriate for selecting individuals for study when subjects are readily available and willing to participate (Creswell, 2012). The study was conducted from the fall semester of 2020 to the end of the spring semester of 2021.

**Data Collection**

The spiral model of action research proposed by Kemmis and McTaggart (2005) was adopted in this study. In this model, each spiral of a self-contained cycle consists of three steps which are (1) planning, (2) acting and observing, and (3) reflecting. These steps took place both sequentially and linearly. Adopting this model provided a systematic framework for the researchers and the two participating teachers to develop, implement and evaluate the preschool project-based STEM modules. In the initial process of planning, the two teachers decided to ask the children to propose a project topic based on their interests. ‘Tree’ was brought up as the preferred topic. Subsequently, the children explored the ‘tree’ with the teachers’ help, following the three phases of the Project Approach (Kartz, 1994) as shown in Table 1.

Data collection centered around the action research cycle of planning, acting and observing, and reflecting. Firstly, the planning and development of the STEM project approach modules (‘Tree’ modules) were examined and documented. Secondly, the implementation of the ‘Tree’ modules was observed together with feedback from teachers, students, and principals. Thirdly, the reflection on the Project Approach was elicited from teachers, students, and principals. The collection of data in these three steps was made possible through regular interviews with teachers, students, and principals throughout the project as well as observations of the lessons in the classroom and during field trips. The method adopted in this study conforms to that proposed by Kemmis and McTaggart (2005) of multiple research cycles within each project, where each cycle will be an improvement of the previous cycle.

**Table 1.** Phases of Project Approach in this study

Phase	Activities
Phase I	Decision of topic, ‘tree’ topic was selected. Children were led by the teacher in discussing what they know, and what they want to know about the ‘tree’ which determines the direction of the subsequent investigation.
Phase II	Children investigate the topic through field trips and interaction with experts and find the answers to their questions.
Phase III	Children led by teachers reflected on what was learned and then complete the project with a culminating event of presentation of their project.

Source: Author

In this action research, two cycles of action research were administered with a total of eleven (11) lessons implemented within the two cycles. The number of lessons was decided based on children's and teachers' needs and reflections. Teachers supported the children to lead the project and to develop their environmental awareness while conducting the investigation based on each of the modules. A module can be implemented in more than one lesson. Each lesson implemented adhered to the plan-act-observe-reflect stages with constant discussions between the researcher and the teachers. The journey of how this action research went on was documented by the researcher.

The data obtained in this study were from the following: (1) classroom observation notes (2) video recordings of each lesson (3) audiotaped interviews with the teachers, (4) audiotaped interviews with students, and (5) researchers' notes. Classroom observation transcripts and notes described how teachers and children interacted in their teaching and learning process as well as the development of children's understanding of environmental sustainability through the Project Approach. Audio-taped semi-structured interviews with the teachers helped to indicate the challenges and support the teachers need to promote children's understanding of environmental sustainability in early childhood education settings. It documented the journey of the teachers in implementing this project. Interviews with students were done in situ as researchers observed and interacted with the children, often with the products of their 'tasks'. It was noted that at times children's tasks were something that the children come through on their own and not a result of teachers' specific instruction.

The developed STEM modules were implemented based on the gathered evidence in the teaching process, and changes were made in teaching practice as the project progressed to improve the quality of environmental education for positive change in children's attitudes and behavior. These modules were often work-in-progress within this research.

### **Data analysis**

Data analysis is the process of 'making sense out of the data' (Merriam & Tisdell, 2015). In this qualitative action research study, the process of data collection and data analysis happen simultaneously, both tightly interwoven, recursive, and dynamic (Corbin & Strauss, 2014; Marshall & Rossman, 2014; Merriam & Tisdell,

2015). The constant comparative method suggested by Corbin and Strauss (2014) was used in this study. The researcher was constantly making comparisons between data obtained and among categories generated until the final findings were confirmed. As this study is a two-cycle of action research, a constant comparison was carried out on two levels. Firstly, comparison within each cycle, that is comparing data collected through all interactions between teachers and children through observation, interview, or journal. The second level of comparison was a cross-cycle comparison. In cross-cycle comparison, categories that emerged from the first cycle were compared with the categories that emerged from the second cycle, and so forth.

Data analysis involved systematic, meticulous, and intuitive processes of open coding, axial coding, and selective coding. The first stage of coding is 'open coding' where data was broken down or taken apart into discrete parts to be compared between each other (Corbin & Strauss, 2014). These parts were then classified or categorized according to similar characteristics. Conceptual labeling was then given to these categories. The second stage of data analysis is the 'axial coding' which aims to form webs of relationship between categories and subcategories (Corbin & Strauss, 2014). Establishing relationships between categories or subcategories is a key feature in the analysis of data in this study. The third stage is 'selective coding' where the core category was sought and the storyline determined. Analysis of data started immediately from the moment the first transcript of data was read and scrutinized by the researcher. The process continued until the writing of the 'conclusion' was completed.

### **Findings**

Interview transcripts and observation notes were systematically examined and analysed using thematic analysis (Braun & Clarke, 2012; Corbin & Strauss, 2014) to answer the research questions.

**Research Question 1:** How were the STEM modules formulated to generate awareness of environmental sustainability?

Data analysis yielded three themes that are related to the impact of the Project Approach STEM modules on the awareness of environmental sustainability among the children. The three themes are: (1) Focus on Basic Scientific Investigation (2) Connect with Nature in Outdoor Space (3) Getting the voice of the children.

These themes have been validated by the participants and experts in this field and are elaborated on in the following sessions.

### Theme 1: Focus on Basic Scientific Investigation

The STEM modules were intentionally developed to encourage the children to explore nature around them. Each module focused on specific activities organized around 'tree' Children were found to be actively exploring the leaves and trunks of trees. The researcher and the two teachers were amazed by the long-lasting enthusiasm toward the natural tree topic, as reflected in the quotes below:

*The children were busy investigating outside their classrooms. Their sustained interest surprised the teachers and the school principal. Accessibility to nature enabled children to explore the natural environment around them. Nature is highly stimulating and engaging.* (Researchers' Note 1)

As the children went around investigating trees based on the activities in the STEM modules, they naturally used the basic scientific skills of observation, comparing, and categorizing, as shown in the quotes from one of the teacher's interviews:

*"My kids were quite excited to explore the outdoors and were able to focus on the leaves in the schoolyard. They spontaneously took the initiative to observe, compare, and categorize different leaves while collecting leaves, doing observational drawings, and sharing their leaves with others. You know, nature invites study."* (Teacher 1)

Children's enthusiasm for the topic enabled them to take the initiative to do observational drawing spontaneously, measuring the circumference of different trunks in the schoolyard, documenting their investigation through photo taking, and achieving deep thinking. For instance, one boy named ZL used photos to document his finding and raised his question, "Why all of the leaves on this tree fell off while the leaves of some other trees are still green?". Nature provides this boy the opportunity to develop a sense of cause and effect. ZL's comparative observation and deep thinking in outdoor learning led to a subsequent classroom discussion on the differences between evergreens and deciduous trees in this tree project. They learned to appreciate the beauty of nature with its different kinds of trees and were led to a discussion on why there is a need to keep more trees in the environment.

The two teachers' reflections from the teacher interviews also demonstrated that children's enthusiasm for the

natural topic motivated them to do experimentation and innovate, which in turn enhanced their self-learning ability. For instance, children's enthusiasm towards making their "big" birds' nest to give the birds their 'home' gave them the impetus to solve problems in a practical way, which was shown in the following quote from another teacher's interview:

*"The kids decided to make a bird nest big enough for a bird family. Through brainstorming, they thought a big and strong base was a must. They worked together to experiment and finally figured out that twisting more straws together to weave the base in a circle shape would be effective."* (Teacher 2)

### Theme 2: Connect with Nature in Outdoor Space

An increase in connection with nature emerged as one feature of this 'tree' project work. The project approach provided the children with outdoor learning opportunities. The original plan was to bring the children to the forest a distance away for field trips. However, due to the COVID-19 pandemic where travel was discouraged, children were brought only to the surrounding of the school where there are different kinds of leaves and trees.

Through multiple discussions and exploration, the researcher and teachers decided on a two-pronged approach, which is, bringing nature into the classroom and bringing the children to nature through field trip visits that include the school compound where trees were planted. The two teachers held that bringing natural resources associated with the tree topic into the classroom will provide children with concrete hands-on experience. This was necessary considering the constraints of traveling due to the COVID-19 pandemic. The participating teachers spoke candidly that the children had limited connection to nature in their traditional learning. They perceived that "real teaching materials" used in classroom teaching would be highly stimulating and facilitated the implementation of the Project Approach in this tree project. They were right as shown in the following quote.

*"My children were excited to use project-based learning modules. They were very engaged in exploring natural sub-topics, such as leaves and trunks, which we brought into the classroom. They participated actively in observational drawing, playing with the leaves and barks which were collected from field trips some were provided by us"* (Interview 3)

Classroom observation notes documented children's enthusiasm and excitement toward learning even within

the limited outdoor space in the school compound. This is a testament to children’s inborn love of learning in nature and could be seen in the following observation note after module 2 (note field trip visit):

*When the children heard they would explore the schoolyard, they became excited and noisy. They shouted to express their excitement. Teacher Lisa and two teaching assistants had to manage the class before the children were quiet enough to listen to the requirements.*

Children’s positive reactions to being connected with nature even though it was within the school compound made the two teachers reflect on their previous teaching. Both of them felt encouraged to design more lessons using natural teaching resources and bringing the children out to nature in their future teaching practice. Quotes from the interview between the researcher and teacher Annie below illustrated this point:

*“My children were interested in these natural things. We should have noticed the natural resources available at the school. It is valuable to consider how to embed these natural, familiar things in future teaching.” (Interview 6)*

At the end of the project, the researchers summarized the features of the STEM modules developed by them as shown in Tables 2 and 3. The STEM modules largely focus both on ‘bringing children to nature’ and ‘bringing nature to children’ through direct, indirect, and vicarious experience. ‘Bringing children to nature’ provides a direct experience for the children. It occurred in two scenarios: first, the children were brought to the forest or parks where trees grow naturally without much interference from human activities. Second, the children were brought to the school compound where trees were planted in a more confined space. On the other hand, ‘Bringing nature to children’ is where resources from nature were brought

into the classroom for discussion and manipulation. This also occurred in two scenarios: first, resources were brought in by teachers (indirect experience), and second, from the use of picture books, photos, or video for vicarious experience.

In this study, all these experiences were found to have influenced the awareness of environmental sustainability. Although the children were provided with three types of experiences that connected them with nature, it is the direct-contact experiences that were critical as children’s investigation was promoted in this study and true environmental education is pursued.

**Theme 3: Getting the voice of the children**

Data collected in this study demonstrated that children’s expanded experiences with nature yielded a positive influence on children’s attitudes and behaviors to nature. Their love and concern for nature were evident in their interaction with their teachers as well as through their work. The STEM modules developed based on Lilian Kartz’s Project Approach focus on getting the voice of the children. For instance, during Module 4 and Module 10, when the children were asked to re-web on the subtopics (leaves and trunk) to represent what was learned in the project, their ideas clearly showed their interest, love, care, and understanding about leaves and trunk.

Figure 1 is the mind map done by the teacher in the class with the children relating to what they have learned from the sub-topic on leaves while Figure 2 is on tree trunks. Children expressed their aspiration to create a green world, protect trees, save and recycle paper, and understand the growing condition of the trees. This is the early beginning of inculcation of the awareness of the importance of environmental sustainability.

**Table 2.** Features of the ‘Bringing children to nature’ in the STEM modules

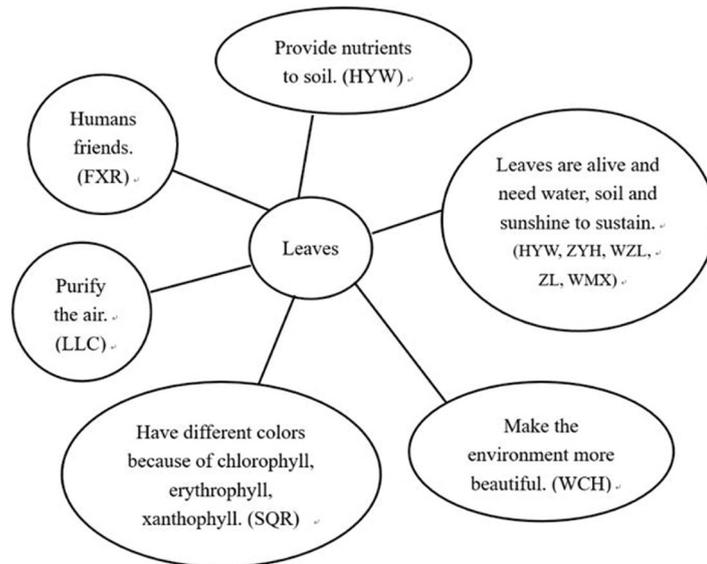
Open Experiences in Natural Setting	Direct Experiences within the confines of the school compound
Unstructured, explorative contact with trees in nature. Children planned and decided their own learning experiences through investigations in nature in each cycle of the action research.	Exploring in the preschool yard. Interaction with controlled nature in the preschool yard, such as gardens with different kinds of trees, leaves, and trunks in multi-task group work. Exploration is limited to what is available.

Source: Author

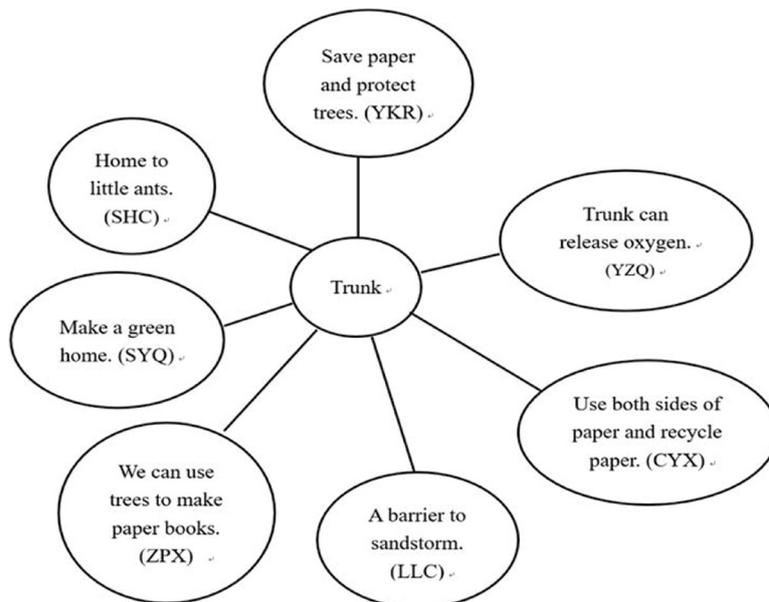
**Table 3.** Features of the ‘Bringing nature to children’ in the STEM modules

Direct Experiences	Vicarious Experiences
Teachers bringing natural resources into the classroom for activities	Abstract learning about nature. Picture books, photos, videos, and media associated with the tree topic.

Source: Author



**Figure 1.** Children's web on what they had learned on the subtopic of leaves  
**Note:** The initial given in brackets is the pseudo name of the children



**Figure 2.** Children's web on what they had learned on the subtopic of trunk  
**Note:** The initial given in brackets is the pseudo name of the children

Children's response indicated their role as the agent of change. For instance, teacher Lisa reflected on the children's spontaneous decision to build bird nests to shelter birds in this action research. The following quote illustrates this:

*"The children decided to build bird nests to conclude the project. To support children's care for birds, one parent donated picture books. Our teachers showed the children videos of many species of birds building nests. Children did their research on how to build bird nests and tried to make their bird nests through hands-on practice based on their concept drawing."* (Teacher interview 12).

After completing making bird nests, the children on their own accord decided to provide shelter for the birds by placing their bird nests on the trees in their schoolyard as shown in Figure 3. They placed the nests carefully, hoping their effort would provide the birds with a better resting place.

The implementation of STEM project-based learning modules appears to expand children's connection with nature and respond to children's needs and interests. The project topic that focused on natural plants (trees) encouraged the children in this study to develop positive attitudes and behaviors toward the natural environment.



Figure 2. Children were placing provision of bird housing in good positions in the schoolyard.

Thus, the curriculum that was developed has increased children's connection with nature and should be implemented as it would help children love, respect, and care about nature.

**Research Question 2:** What are the challenges and barriers to designing and implementing the STEM project-based learning modules in the Chengdu preschool?

Based on the data collected, this study revealed a confluence of four major barriers in teachers' implementing the STEM project-based learning modules: (1) Lack of time for planning and reflection (2) Lack of professional training (3) Challenges in the management of children's behavior in outdoor learning (4) Pressure of preparing the child to enter formal primary school education.

### **Lack of time for planning and reflection**

The two teachers asserted that "lack of time for planning and reflection" was one of the influencing factors that undermined their tree project practice. Given a large amount of material to cover in their existing curriculum and the developed STEM modules, the two teachers perceived that they were not able to implement the project-based learning to be entirely child-led. Also, they pointed out that fulfilling each phase of action research was time-consuming. For instance, teacher Lisa reported that:

*"Project work in action research requires extra time for planning, implementation, and reflection. After each module, you have to prepare, carry out, and reflect. It was also labor-intensive". (Interview 9)*

*"For this tree project, we had to squeeze out time. Children who are entering primary one must have some compulsory bridging courses as expected by their parents. They also need to prepare in many aspects, such as practicing*

*appropriate classroom behavior and good learning habits."*

### **Lack of professional training**

The two teachers initially expressed their hesitation in doing projects on environmental sustainability. As projects on the environment often lead to teaching science, they were not as prepared to teach science as they are for language and other humanity disciplines. Furthermore, sustainability is a big term. Teacher Lisa reported;

*"Despite the increased curricular attention to mathematics and science, they tend not to be emphasized by teacher preparation or in-service professional development programs"*

Both teachers also said that they hesitated to do a project on nature because they did not have many experiences with nature during their own learning journey. Besides, both teachers initially believed that studying nature during the COVID-19 period was impossible because their preschool is located in a city. They were also discouraged from traveling far with the children. As they progressed to do the "Tree" project, they were surprised to learn that nature can also exist within their urban preschool environment.

The two teachers also stated that they had only briefly learned about the child-centered Project Approach and other Western-derived progressive pedagogies from their respective teacher education programs. As teacher Lisa shared below:

*"We learned about the Project Approach in school. But it was just one of the pedagogical approaches mentioned in class. We did not discuss nor study it in depth and seldom apply it to our teaching practice."*

Although they were provided with this study opportunity by the preschool to experiment with a different mode of teaching, both teachers did not feel they were competent enough or fully equipped with the knowledge and skills required to implement the Project Approach. The topic "environmental sustainability" seems to be too 'far-fetched' for them. Teacher Annie explicitly said:

*"It would be better if we could have more long-term and systematic training on how to practice Project Approach in environmental education."*

Echoing Annie, teacher Lisa also stated:

*"Professional training on Project Approach is not enough. I had little teaching experience with cases utilizing this Approach."*

Both teachers however agreed that expert guidance would assist them in identifying problems and finding solutions in their project-based teaching.

### **Challenges in the management of children's behaviors in outdoor learning**

Managing a group of young children in an outdoor setting is challenging for any teacher. Children tend to be noisy as outdoor learning provides an escape for them from the rigid and restricted conditions in the classroom. Thus, it is not unexpected that the two teachers admitted the "management challenge" as an influencing factor in implementing the tree project through a project approach. The teachers held that children had limited opportunities to use real natural materials in the classroom and to learn outdoors in nature in their traditional learning. Thus, the increased connection with nature in this study made the children happy and excited, which resulted in difficulty in managing children's behaviors. Also, recognizing that just as they needed to get prepared for formal schooling academically, the children were required to form moral virtues (e.g., behavioral control, discipline, conformity). For instance, the two teachers often reminded the children of the importance of being quiet and listening attentively when someone is talking as a means to develop proper behavior. Teacher Lisa emphasized in this way:

*"Children have to know that listening is a class rule. They were talkative, but they also need to learn to listen attentively to a speaker. We, teachers, should train them for good behavior. It is beneficial for their future development."*

### **Discussion**

In recent years, environmental education has gained increasing global attention as an important subject area in early childhood education. It is becoming obvious that the earth is facing great challenges of survival. Thus there is an urgent need to educate the young generation about the importance of environmental sustainability so that they are ready to plan and act to reduce future worsening of climate change, combat pollution, and ensure the sustainability of quality of life through sufficient clean air, clean water, and sufficient food. This action research explored ways to increase children's awareness and understanding of environmental sustainability through developing and implementing STEM project approach modules. The findings from this study found that the use of STEM modules did increase children's connection with nature and helps develop their positive attitude and behavior toward environmental awareness and sustainability. The findings support studies conducted by Ernst and Burcak (2019) and White (2004) who concluded that using nature experiences within the early years of children's life could help them develop feelings of love, care, and respect for the natural environment.

This connection with nature needs to be occurring more regularly and not just sporadic (Kals & Ittner, 2003; Phenice, 2003; Sobel, 2004). Bogner (1998) brought the purpose of education for environmental sustainability to a higher level by saying that children involved in an outdoor education intervention were more sensitive to environmental protection and more willing to take action to protect the environment. This sense of agency is developed early among the children and it augurs well for a greater possibility of future action especially when they reach adulthood. The finding of this study also concurs with Robertson's (2009) discovery in a longitudinal study that children who interacted with nature more will have more affection toward animals after they were involved in nature-based education.

The participating children in this study were typical urban children with limited access to nature in their formal schooling. Their learning activities were previously more directed by their teachers in a brick-and-mortar manner. These children seldom have opportunities to lead their learning, and they only have access to several manufactured materials such as man-made toys. In this study, children got the opportunity to decide what to explore under the subtopics of leaves and trees. Teachers playing a reverse role implemented

the teaching by following children's interests. The implementation of this STEM project approach modules provided these children with the time and place needed to interact with nature. As suggested by Fismann (2005), these outdoor types of activities helped the children to grow their environmental awareness. At the same time, the opportunity of hands-on interaction with nature has provided the children the opportunity to sharpen their acquisition of basic science process skills of observation, comparison and contrast, categorization, etc.

In this action research study, the teachers shared the challenges they faced. These include the lack of time, lack of support, and the feeling of insufficiency in their competence to take the heavy load of education for environmental sustainability. To increase the effectiveness of environmental education in early childhood education, it is recommended that teachers follow children's interests and integrate them into all education activities in a manner that reinforces the learning of children rather than during a limited period of instruction time in a specific subject. Providing regular connection with nature for children requires collaboration among teachers, parents, and preschool principals (Li et al., 2012; Rao et al., 2010). For preschools lacking natural resources, teachers and principals could seek public support and advocate for parents to help find the needed resources. Parents could be involved in project work during field trip visits in the natural environment. Increased children's connection with nature would be supported by parents when they are fully informed about what is planned and expected and the main purposes of the site visit in nature (Li et al., 2012). This requires teachers to plan elaborately and collaborate well with parents. Teachers could also connect child-centered project work with environmental education. Thus, preschools need to give teachers training on how to use project approaches to promote education for environmental sustainability.

## Conclusion

As teachers search for a pedagogy for educating children in environmental sustainability, a project approach is a good choice in the preschool in Chengdu China. Within the six (6) months duration of the project, it was observed that the children were stimulated and excited about learning, their environmental awareness grew, and they seem to show an initial sense of agency in wanting to play a part in their environment. While the students learned about the sustainability of the environment, their

teachers too grew in their pedagogical knowledge and learned to think of the project approach as a possible pedagogy to be used in their future teaching. However, some challenges need to be overcome including time constraints and professional development. These challenges need to be managed for the sustainability of the impact of the project approach.

## Recommendations for Future Studies

For future research possibilities, longitudinal studies could be conducted during the later life stages of children who have experienced environmental sustainability education in early childhood education. This type of study could explore whether the early experiences they had would continue to influence them. Second, further research could be conducted to explore children's development of positive attitudes and behavior toward nature when they have been exposed to project-based teaching and learning approaches in early childhood education. Third, the research could be conducted that follows preschool children into primary school settings where project-based education practices are employed to gain insight into how and whether children continue to improve in their environmental awareness and action as they grow older.

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## References

- Ballantyne, R. R., & Packer, J. M. (1996). Teaching and learning in environmental education: Developing environmental conceptions. *The Journal of Environmental Education, 27*(2), 25-32.
- Bogner, F. X. (1998). The influence of short-term outdoor ecology education on long-term variables of environmental perspective. *The Journal of environmental education, 29*(4), 17-29.
- Braun, V., & Clarke, V. (2012). *Thematic analysis*. American Psychological Association.
- Cagle, N. L. (2018). Changes in experiences with nature through the lives of environmentally committed university faculty. *Environmental Education Research, 24*(6), 889-898.
- Champeau, R., Gross, M., & Wilke, R. (1980). An assessment of teachers' understanding and use of 'Goals for Curriculum Development in Environmental Education.'. *Current Issues VI*, 218-226.
- Corbin, J., & Strauss, A. (2014). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Sage publications.
- Corraliza, J. A., & Collado, S. (2019). Ecological awareness and children's environmental experience. *Psychologist Papers, 40*(3), 190-196.
- Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Pearson Education, Inc.
- Ergazaki, M., & Andriotou, E. (2010). From "forest fires" and "hunting" to disturbing "habitats" and "food chains": Do young children come up with any ecological interpretations of human interventions within a forest? *Research in Science Education, 40*, 187-201.
- Ernst, J., & Burcak, F. (2019). Young children's contributions to sustainability: The influence of nature play on curiosity, executive function skills, creative thinking, and resilience. *Sustainability, 11*(15), 4212. <https://doi.org/10.3390/su11154212>
- Fisman, L. (2005). The effects of local learning on environmental awareness in children: An empirical investigation. *The Journal of Environmental Education, 36*(3), 39-50.
- Gunderson, R. (2014). Erich Fromm's ecological messianism: The first biophilia hypothesis as humanistic social theory. *Humanity & Society, 38*(2), 182-204.
- Helm, J. H., Katz, L. G., & Wilson, R. (2023). *Young investigators: The project approach in the early years*. Teachers College Press.
- Kals, E., & Ittner, H. (2003). Children's Environmental Identity, Indicators and Behavioral Impacts, in Identity and the Natural Environment, The Psychological Significance of Nature, Clayton, Susan and Opatow, Susan. *The MIT Press, Cambridge, Massachusetts*.
- Katz, L. G. (1994). The Project Approach. ERIC Digest.
- Li, H., Rao, N., & Tse, S. K. (2012). Adopting western pedagogies into teaching Chinese literacy: Comparison of Hong Kong, Shenzhen and Singapore preschool classrooms. *Early Education and Development, 23*(4), 1-19.
- Littledyke, M. (2004). Primary children's views on science and environmental issues: examples of environmental cognitive and moral development. *Environmental education research, 10*(2), 217-235.
- Marshall, C., & Rossman, G. B. (2014). *Designing qualitative research*. Sage publications.
- Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. John Wiley & Sons.
- Nelson, C. A. (2001). The development and neural bases of face recognition. *Infant and Child Development: An International Journal of Research and Practice, 10*(1-2), 3-18.
- Otto, S., Evans, G. W., Moon, M. J., & Kaiser, F. G. (2019). The development of children's environmental attitude and behavior. *Global Environmental Change, 58*, 101947.
- Otto, S., & Kaiser, F. G. (2014). Ecological behavior across the lifespan: Why environmentalism increases as people grow older. *Journal of Environmental Psychology, 40*, 331-338.
- Palmer, J. A. (1995). Environmental thinking in the early years: Understanding and misunderstanding of concepts related to waste management. *Environmental Education Research, 1*(1), 35-45.
- Phenice, L. A., & Griffore, R. J. (2003). Young children and the natural world. *Contemporary Issues in early childhood, 4*(2), 167-171.
- Rao, N., Ng, S. S., & Pearson, E. (2009). Preschool pedagogy: A fusion of traditional Chinese beliefs and contemporary notions of appropriate practice. In *Revisiting the Chinese learner: Changing contexts, changing education* (pp. 255-279). Dordrecht: Springer Netherlands.
- Robertson, J. S. (2009). *Forming preschoolers' environmental attitude: Lasting effects of early childhood environmental education*. Royal Roads University.
- Sobel, D. (2004). Place-based education: Connecting classroom and community. *Nature and listening, 4*(1), 1-7.
- Unesco, P. N. U. E. (1978). Final Report, Intergovernmental conference on environmental education, Tbilisi (USRR), 14-16 Oct. 1977. *Paris (France)*.

Wals, A. E., & Benavot, A. (2017). Can we meet the sustainability challenges? The role of education and lifelong learning. *European Journal of Education, 52*(4), 404-413.

White, R. (2004). Young children's relationship with nature: Its importance to children's development & the earth's future. *White Hutchinson Leisure & Learning Group, 16*(2), 1-9.

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