



Applying Gardening Projects to Improve Scientific Knowledge and Collaboration in Early Childhood Education

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Abstract. The goal of this study is to investigate children's involvement in gardening project to improve their scientific knowledge and collaboration amongst their peers and adults in the preschool. The method of this research is a case study with inquiry-based approach using 5E (engagement, exploration, explanation, elaboration and evaluation) where gardening as the main activity. Children were observed and documented to collect data during four meetings of the study. Meanwhile, the study site is a childcare in Gorontalo with the total children involved are eighteen. The results show that gardening activities provide children with real-life experience and boost the knowledge of plants. Also, they are capable to lead their own learning which is driven by their curiosities, open-ended questions and the opportunities to experiment and collaborate in this science project. Teacher also has indispensable role not only to achieve the curriculum standards but importantly, facilitating children's learning through exploration in order to provide meaningful and factual experiences during their childhood period.

1 Introduction

Science is a way of knowing the phenomena around us, for example, wondering how rainbows appear or how to grow plants. Similarly, scientific literacy is viewed as part of daily life activities such as "thinking, finding, organizing and using information to make decision" [1]. Meanwhile, it is believed that considering science as a difficult knowledge to comprehend decrease the awareness of learning science. This belief has influenced on how science is presented in both education and policy, where science is often associated with a subject that is hard to comprehend for certain ages and group of people. However, this view has been challenged that everyone can learn science if it is presented in real-life example [2, 3].

Learning science is mostly started by curiosity which is one important trait of children [4]. Children are curious and eager to experience new things, and this should be encouraged in Early Childhood Education and Care (ECEC) [5]. Teacher needs to develop their teaching practice to genuinely support, pre-school age children in order to construct knowledge. Indeed, investigating science activities as meaningful and joyful, yet

challenging experience will increase children's interest [6]. Importantly, traits of curiosity in children leads them to wonder and question their environment in order to make sense of their world. At the same time, emphasizing on the diversity of classroom, which values their voices and needs are essential to improve their participation. Additionally, the acknowledgement that every child is unique and capable of contributing, enhances their willingness to learn. This is in line with sociocultural perspective that views "children as capable and competent learners" [1, 7]. It states that children can contribute to influencing the curriculum and pedagogy by revealing their feeling or ideas. Therefore, children's voices need to be involved in planning the activities by providing dialogue.

Introducing science for preschool children is pivotal. 3 to 6 years old children are the perfect age to introduce science and provide them with hands-on activities. These children are naturally curious to explore, create, and innovate in their environment [8]. Creativity, curiosity, and persistence are the traits of these preschool children [9]. Science activities provide preschoolers with a natural environment for collaboration and communication. They are capable of discussing different strategies and suggestions for a simplistic engineering design.

The world of wonder in children world captures an emotional quality between their environment and that this can be pedagogically supported in preschools by teachers [4]. It needs a strong foundation to build and to truly facilitate children with the world of science. Long-term learning that should be integrated into the daily activity is needed. This relationship can be established only if children are helped to develop certain attitudes towards science.

Wondering can be viewed as a qualitative relationship of the child to their environment. Knowing more about the scientific possibilities within preschool environments is important for noting what children can wonder about. The opportunity of children to realize and discover interesting things for themselves, it shows their first encounter with science has occurred, for example, through "wondering, questioning, and formulating ideas and theories" are part of scientific enquiry into the world surrounding children [8].

Another essential benefit of using scientific activity is to improve collaboration [10]. Collaboration is a skill most needed in the 21st century. Through collaboration, children learn how to respect different opinions, how to accept other people ideas for achieving shared goals, and how to work together as a team.

However, the exploration of children scientific activities tends to have limited opportunity to fulfil their curiosity. This can happen because of certain reasons such as children's voices and interests are less included in planning, science activities are too structured without flexibility to exploration and less time allocation for science activities and also many teachers reckon that children will find science activities difficult so they unconsciously limit children involvement to create and be curious about the science activities [9]. Unfortunately, the practices of teacher in school are not rooted from scientific works but mostly from their beliefs. It can be challenging because teacher beliefs will transfer into curriculum that will be the policy of the school regarding science learning [11]. Therefore, this study provides many scientific activities as opportunities for teachers to shift their traditional beliefs about science.

Gardening as project to improve scientific knowledge and collaboration.

The gardening activity will be used in this project, which emphasizes the creative aspects of learning and encourages discussion and collaboration. The process of gardening aims to provide real experience for children that integrates with curriculum and their individual needs. It is called as “hands-on” activities, which investigates data or facts through doing it [5]. Importantly, the hands-on inquiry is evidently interesting and interactive compared to teacher’s lecture [12]. It introduces a problem that needs hands-on exploratory tasks and inquiry. Meanwhile, the gardening project not only focuses on science but also arts, for example, doing drawing and writing activities. Drawing and writing are powerful tools to reflect children’s understanding of the process, at the same time, it helps them to co-construct and remembers their learning [13]. Therefore, this project aims to provide knowledge about nature through creating a garden, which emphasizes how to plant plants.

As a result, the inquiry-based approach is benefit to teach science because it encourages children to question phenomena critically and logically [5]. Additionally, maximizing children’s learning in Arts and Science can be achieved by doing hands-on activities. For example, creating a mini garden in school is a hands-on activity that uses authentic materials for investigation.

Furthermore, the 5E learning model will be a guided inquiry in the process of gardening [12]. The 5E learning: engagement, exploration, explanation, elaboration and evaluation, occur during the process. Importantly, environment is critical to support young children learning Arts and Science because it provides children with real experience, where they can construct their knowledge and make sense of their world [4]. However, the time provided to truly explore the usage of the environment is minimum in teaching. Therefore, this study would plan an activity, that allows children to engage with the natural environment.

This study sought to determine:

- What science learning opportunities are possible for gardening project for 4 to 6-year-old children attending a preschool?
- Can gardening activities improve children scientific knowledge and collaboration?

2 Method

2.1 Context of the Study

This study is a case study, from one preschool in Gorontalo city. This preschool has 18 children with age range around 4 to 6 years old. Meanwhile, services provided in this preschool are full-time daycare and occasional day care. It means that children who enroll in the full-time daycare will spend more than 8 h while occasional means children can only attend two times or more in a week. Many of the children and families know each other from other community activities. Space in the center is constrained but has a backyard as a mini garden. Additionally, the total numbers of staff and teachers are 4 people with different range of educational backgrounds. Two teachers have diplomas in early childhood education and the other two are high school diplomas. Importantly, teachers and researchers collaborated to define the gardening activities and integrate to the inquiry-based science. The knowledge of children’s context and interests in school

is significant to establish a plan for their learning [14]. With this thought, the gardening project is chosen because it supports children's eagerness and curiosity to explore and learn about nature.

2.2 Data Sources and Analyses

To gather the data and information from this study, the researchers use video recordings of children from planning and implementing gardening project and photos to capture meaningful activities. Both videos and photos then collected, selected and analyzed. The teachers were informed about the project earlier and they have talked to parents, therefore, the project was done with the parents' consent. Furthermore, the gardening activities were conducted in four meetings, where researchers, teachers and children were actively engaged in this project. This gardening project was chosen because it is one of the main themes in early childhood education curriculum. Time allocation for each meeting was 2 h for each meeting.

The inquiry-based approach was chosen to allow children as the center of teaching where they are capable construct their knowledge and fulfill their innate curiosity. Inquiry-based approach is rooted from constructivism theory, which emphasizes developmental children's readiness to explore and ask good questions [15]. Additionally, observing and recording the development of children allows teachers to employ appropriate pedagogical strategies, in order to construct and co-construct theories about children's world. This relationship relies on the ability of teacher to identify children's interest and providing activities where children are curious and actively asking questions. Engaging children with the inquiry-based project encourage children to gain and connect their findings with their prior knowledge which open opportunities to deeply engage with science in the future [16]. As a result, establishing inquiry-based science activity for young children both fulfil the curiosity of their world with collaboration and encourages them to continue learning science.

3 Result and Discussion

The study was conducted into four meetings as follows:

3.1 The 1st Meeting (Engagement and Scaffolding)

In this first meeting, it aimed to identify parts and benefits of plants, to introduce children with the gardening activity and include children's voice and uniqueness in the activity.

It started with the researchers asked open-ended questions, for example, "do you ever seen flower? who have eaten banana?", to start the conversation.

One child answered "I love banana, I eat this morning, it's yellow"

Another child responded by saying "Banana is yummy, fried banana"

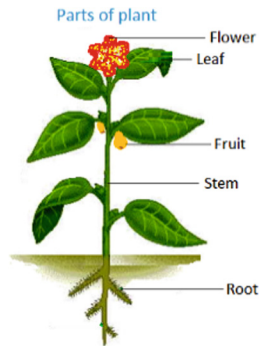
Meanwhile, one kid stated "I have many flowers in my home, my mom waters it"

The researcher then showed a picture of plant and started to elaborate the children answers and explain part of plants, such as leaves, stems, root, and flower by using pictures.

The other activities then continued by first introducing the gardening project and the activities, such as steps to grow plants and what are needed to grow plants (water, the sun, soil, etc.). Then Teacher read “the carrot seed” book, to engage children with plants. Furthermore, children get opportunities to ask questions or clarify regarding the plan, starting with the word “I wonder”. This aims to increase the curiosity of children, at the same time, inviting them to add ideas, for example, they say “I wonder if I can plant a flower”. The teacher then can use children’s ideas in the activity.

Children draw their own imagination about plants and gardening in their journal. The teacher provides imagine and asks children to see outside the window. There are many plants around them, then asking them to express what they see their drawing to enhance their creative thinking. For example, flowers or leaves (Pictures 1 and 2).

The materials used were



Picture 1. Picture of plant



Picture 2. Story book “the carrot seed”

During the activities of the first meeting, teacher and researcher posed some questions, in order to assess children's prior knowledge about the topic [12]. Allowing children to express their opinions and imaginations about the topic enhances their engagement and invites children to truly explore all information they need.

Meanwhile, children were helped with scaffolding through picture and reading. Using visualization can add ideas and create imagination to stimulate children's interest in science. Importantly, teacher needs a flexible awareness to provide learner moments, which emphasizes on collective activities to help children construct their knowledge [5]. To achieve that teacher has to improve their understanding on a various type of pedagogies to gain their self-esteem of teaching arts and science, at the same time, teacher is able to accommodate children's who may not speak the same language. Therefore, when teachers are confident of their subject knowledge, they will be able to maximize the children's potentials in learning [17]. Additionally, documenting children learning through photograph their drawing. Its purpose is to make learning becomes visible and share the discoveries of children. Each meeting, they wrote or drew the information they have gotten, that they consider crucial, for example, the words "leaf and root".

3.2 The 2nd Meeting (Experiment and Exploration)

Second meeting aims to facilitate children with real experiences and exploration of planting plants through hands-on activities. It begins with teacher and researcher provided the pots, soils and seeds in the backyard of the school. Teacher then demonstrated how to plants the seeds and explaining the gardening activities to recall the explanation of previous meeting. For example, teacher puts soil into the pot and dig to plant the seed and water it.

Children are encouraged to ask questions, regarding the activities.

One child asked, "why do you put soil?"

Teacher then saw this opportunity to ask other children's opinion to answer the question.

Two children raised their hand and answered the question by saying, "this soil is the food for the plant" and another child added, "the plant needs to be watered for drink, just like us drinking water".

Teacher then asked children to do their own experiment after observing and seeing example on how to using pot, soil and seeds. Children interacted to their peer to negotiate the best way to plants the seeds. During this activity, the teacher encouraged children to help and communicate with each other, when they face difficulty.

One child took initiative by asking his peer how much soil needs to be used.

Another child then showed two fingers which meant two scoops.

One girl said "three".

Then the child stated "two and a half, ok?".

Others stated, "yes".

These activities ended when children put their name tags in their pot, place it outside the classroom and water it together.



Picture 3. Children are watering plants

Teacher stood to observe, help and document this process through journal and photographs to provide rich evaluation on the practice.

Picture 3 shows children were working together to water the plant while discussing how much water should be given to this plan. In this process they found the question that needed to be answered and they discussed and decided that they would take turn water the plant until their bucket is half empty.

This exploration phase focused on encouraging children's curiosity by allowing children to experience and doing the activities [12]. Modelling the activities and providing opportunity for children to ask questions as part of inquiry process. Although modelling provides children clear pictures on how to do the activities, they were allowed to modify what they have seen or made mistakes. Because it provides discussion and communication to work collaboratively with their peers, to find the best solution. Collaboration occurs regarding sharing and detailing ideas and solutions [14]. Children learnt to negotiate their opinions and accept differences in order to do the activity as a team. This situation enhances children's ability especially problem-solving.

3.3 The 3rd Meeting (Explanation and Co-construct Children's Knowledge)

In the last meeting, teacher and researcher focused on wonder of children's experience and emotion towards the gardening activity. It was started by letting children to tell their experiences from "engagement" and "exploration" activities with gardening.

One child answered, "I grew a tiny plant that will be bigger than me later, it will have leaves and long root".

Another child stated, "I planted flowers that will have different colors just like rainbow but it is not in the sky but in the ground".

Another boy shouted, "I watered many plants because they need to drink but if it is rain, I don't have to do it, it will drink from the rain".

Later on, teacher used the inquiry to ask questions, regarding children's emotions, process and memory. For example, "did you enjoyed the gardening project? What the best experience in gardening?". Most of them have positive experiences about gardening because it allows them to be the main character of their own learning means that they are not afraid to try things.

Next, children's journal and photographs were used to assess their understanding, for example, one child drew a little seed, teacher then asked "what are you drawing here?" the child then answered, "it is a Rambutan seed, because I like it and I want to eat it



Picture 4. One child tries to create leaves

every day, yummm.. yummm”. Then the teacher continued by asking “what should we do so this tiny Rambutan seed can go bigger?” one child answered, “water it, put more soil for its food, visit it to know if it is ok, clean the soil” and so on. Furthermore, the teacher chose a photograph during the gardening activity, and asked the children about it.

Teacher: “what are you doing in this photo?”.

The child: “I clean the pot from other plants”,

Teacher then asked follow up question: “why do you need to clean the soil in the pot from other pants?”.

The child: “to distract other plants eating my plant’s food”.

Meanwhile, teacher showed a photograph of a child working to make some leaves from paper that he has seen in the garden. Then teacher opened a discussion as follows:

Teacher: “what are you doing in this picture?”.

The child: “I make leaves just like I saw in the garden”.

Teacher: “Wonderful, it is green, the color of leaf”.

The child: “I don’t think so, I saw there is brown leaf, red leaf, leaves have many colors”.

During this activity, it showed that children started to co-construct their understanding about the different colors of leaves. The child realized that people can have different opinions and he tried to negotiate others’ knowledge by providing example to back up his opinion. This means that children are able to have productive discussion if provided with the real context of learning (Picture 4).

Last activity was playing a game with flashcards where children had to guess the name of the picture, such as parts of plant and different kinds of activities in the gardening project, like watering plant. This game aims to help children on reflecting and recalling the information that they have obtained [14, 18].

These activities also inform teacher about children’s positive or negative feeling, in order to improve their learning experiences and disposition towards science. The acknowledgement of children’s emotion will provide insight on how to re-structure further activities to make it meaningful for them. Accordingly, children will develop positive attitude about plants, particularly vegetables and fruits where teacher emphasizes to children to avoid wasting their vegetables and fruits.

All processes aim to co-construct children’s knowledge by combining their prior knowledge and experiences to have full understanding of the world around them. Additionally, teacher and researcher also provided explanation on what activities children have

done, in order to deepen their understanding by extending the learning about advantages to grow plants, for example, providing fresh air and foods.

3.4 The 4th Meeting (Evaluation and Documentation)

The last meeting was conducted without the children. Researchers and teachers were working together to discuss two things. First, they were working together to assess children's understanding about the plants and gardening activity and secondly to engage with family by showing the photographs of gardening.

Documentation is a way to assess children's learning by displaying photography and journal where children keep their drawing and writing during the activity. It also aims not only to document children's learning and report the process of gardening but to predict and plan further activities [19]. Additionally, evaluation phase will not only focus on the product but emphasize the importance to observe children's involvement from the beginning until the end of the project and connecting the journal with their observation. Traditionally, teacher only assesses the product of children's understanding through memorizing the facts or cognitive skill without valuing initiative and effort during the process of knowledge construction [14]. However, documenting activity from the beginning until the end is crucial to assess their development. By using documentation, teacher will provide time and space for children to think and generate ideas, which maximize their learning process. Therefore, teacher should understand every critical moment from selection problem/topic until reaching conclusion to document children's learning, at the same time, as reflection of their practice.

Based on the aforementioned activities, the inquiry-based approach has provided benefits and fulfilled children's curiosity through searching for evidence and explanation [5]. Children are encouraged to be the main actors of their learning in order to build and co-construct their knowledge of knowing the world around them. Through gardening activities not only exposed children with the real and hands-on experience of learning science but allowed them to work together with their peer and adults (teachers and researchers).

Furthermore, with the advent change of research such as the use of video to record young children's learning has shown that these children construct their knowledge in more scientific way [3]. Children often gather information through perceptual and motor learning which may not appear to resemble scientific learning. But it is the most children are using their senses to discover new knowledge that is scaffolded as first step of learning science. In fact, the process of children learning science is quite same way that scientists do. They start by using their senses by analyzing patterns in the data, doing experiments, and learning from the data and ideas of other scientists. Children integrate prior knowledge and new evidence during the scaffolding process.

Meanwhile, collaboration is one aspect found in gardening activity. It shows that children easily interacted with their peer to discuss, evaluate, challenge or even question each other. They often tried to find a way on how to deal with their differences, as shown for example on how to measure the amount of soil. This can happen because gardening through inquiry-based approach provides the situated context where they can face challenge, make mistake and figure out the best way to solve it. In collaborative interactions characterised by mutual collaboration, children engage in productive dialogue [20] about

the reasons for watering plants. Therefore, the collaboration happened in the gardening project was mostly started by children where they are capable to provide productive discussion.

4 Conclusion

The gardening plan is evidently providing children with real-life experience and boost the knowledge of plants. The teacher used every input from the children to provide meaningful experiences and develop their collaboration to find reasons and solve problem they have encountered. In brief, learning science for young children is essential to develop their critical and logical thinking [5]. It shows how children co-construct their knowledge by the input of their new experiences. They are capable to lead their own learning which is driven by their curiosities, open-ended questions and their opportunities to experiment with this gardening project. It reveals that by engaging science at young age, they potentially develop positive attitude toward science because it fulfills their wonder and increases their ability to work in group. To support these aims, teacher has indispensable role not only to achieve the curriculum standards but importantly, facilitating their learning through exploration in order to provide meaningful and factual experiences during their childhood period. Therefore, inquiry-based pedagogies have offered some effective strategies to introduce science. It aims to maximize children's abilities as active and capable learners.

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