Fostering Children's Interest in Science Learning Through the Use of a Hands-On Gardening Activity

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for the Bachelor of Science Degree in Child Development

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Introduction

Research shows that 3-4-year old children ask an average of 76 information-seeking questions per hour (Chouinard, 2007). This statistic demonstrates that children are curious about the world around them. It has been shown that early interests about science, in particular, are strong predictors of later opportunities to engage in informal science learning (Alexander, Johnson & Kelley, 2012). Informal science learning can be defined as a process of gaining knowledge and understanding; capabilities and skills; ways of thinking; feeling and attitudes; and/or ways of acting which take place in out-of-school contexts (Bell, Lewenstein, Shouse & Feder, 2009). In just one year, U.S. children as young as five years old will partake in over 300 informal science learning activities, such as watching television, reading, attending exhibits or event at community facilities, and asking questions of parents (Korpan, Bisanz, Bisanz, Boehme & Lynch, 1997). Informal science learning centers, such as museums, offer visitors an opportunity to engage in scientific reasoning in a designed setting in which visitors can interact with phenomena, see what happens, develop their own explanations for what they just experienced, and learn about how others explain those same phenomena (Fenichel & Schweingruber, 2010). In situations where the science learning is relevant to the participant, participants' knowledge increases as does their interest level (Fusco, 2001).

Gardens have been used as a way to make science learning relevant and applicable to children's lives by offering direct experience of a phenomena that children can experience both

within and outside of informal science learning venues (Fusco, 2001; Hale, Knapp, Bardwell, Buchenau, Marshall, Sancar & Litt, 2011). In this project, we reviewed existing understandings of how children and families engage in informal science learning during visits to museums and gardens. We then developed and implemented a learning workshop designed to increase children's science learning and interest by engaging them in activities related to gardening and plant growth.

Our workshop was titled "Little Farmers" and was a one-day event that took place at the San Luis Obispo Children's Museum. The main goal was to facilitate parent-child interactions in an informal science learning setting. In order to do this, we developed several activities that included: seed planting, reading, coloring book, games, photo opportunity, and prompting signage. We worked with the museum staff as well as with local farming businesses to make this workshop happen. The visitors on the day of the workshop consisted of about 20 families with young children, ranging from 2 to 10 years of age. When visitors entered the area, we had a parent-guide handout that discussed all the available activities, as well as a brochure for the parents to take home as they left. The brochure was intended to extend the workshop and bring more relevance into the learning objectives.

The most popular and engaging activity was the seed planting station, where parents and children worked together to plant the seeds and discuss the process of growth. The planting station included children scooping dirt and planting a seed of their choice. The photo opportunity was designed as a take-home element for the parents and children to remember the workshop. The reading station had books checked out from the local library and was intended to provide a narrative aspect of learning. The coloring book station allowed for children to express their

understanding of plants and the growth process in a creative way. We created two games: a plant growth cycle game and a matching game. The plant growth cycle game had the children organize different stages of plant growth in the correct order. The matching game had pictures of seeds and the fruit or plant with facts about each one on the back and was designed to have the children match the correct seed and plant. Several of our activities could have benefitted from more facilitation, such as the games and reading stations.

We designed the workshop to be guided by the parent or the child in order to facilitate their interactions. However, lack of facilitation at each station led to low participation in several activities, including our games. Due to the low interest in our games, we chose to do a follow-up activity with a local Girl Scout troop to see if the games were effective. There was a positive response, which revealed that an older audience and increased facilitation was crucial to interest in the games, which led to learning.

We provided evaluations in the form of a Likert scale for the parents to complete after going through the workshop. We found all parents either “agreed” or “strongly agreed” that the workshop provided their child with new information as well as providing opportunities for parent-child interactions. Parents all gave positive feedback in the comments section of the evaluations, leading us to believe that the workshop was a success. The museum staff also completed evaluations about the workshop. They “agreed” and “strongly agreed” that “Little Farmers” would be worth having again and that it was successful in providing information as well as opportunities for parent-child interactions.

If this workshop were to be done again, improvements were suggested to increase the engagement with the activities and parent-child interaction as a whole. We would suggest

facilitating each activity as well as a location that had fewer distractions. We also discussed the potential benefits of doing it in a different informal learning setting such as the local farmers market or a school open house. These would still allow for parent-child interactions to occur and children to engage in informal science learning. Overall, our workshop was a success at providing a space for parent-child interactions to engage in informal science learning.

Learning Outside of School: The Role of Informal Science Learning Opportunities in Children's Everyday Lives

Informal science learning refers to the experience of learning about science outside of the school setting. There are many places science learning can occur, some structured and designed, and some unstructured and spontaneous. Unstructured informal learning settings consist primarily of natural and home environments where children might engage in such activities as going on a hike, baking a cake, or helping parents with yard work. Structured informal science learning settings include non-school venues that intentionally include a science learning element, such as zoos, science programs on TV, science centers, and museums. Due to the opportunity to collaborate with a local children's museum, we focused our project on children's learning about science in the context of museums and science centers.

Research shows that exposure to informal learning opportunities is related to a child's interest and understanding. Alexander, Johnson, and Kelley (2012) analyzed the relationship between children's reported interest level in science and their opportunities for science learning. The participants included 192 families with children between the ages of 4 and 7 years who participated in a longitudinal study over the length of 12-months. Parents completed a

questionnaire when their child was four, five and six years of age. The first two questionnaires asked the parents about their child's science-learning opportunities. The third questionnaire asked more detail about science-related activities. To measure the child's interests, parents reported on their child's preferences for activities and if their child had a focused interest. Alexander et al. found gender differences in the frequency of opportunities for science learning with "parents of boys reporting more science-related opportunities than parents of girls" (Alexander et al., 2012, p. 774). Further, results revealed that early science interests were strong predictors of later opportunities to engage in informal science learning. Parents seemed to respond to this interest by intentionally creating contexts for the child to learn science concepts. These findings demonstrate that parents are in a key position to help shape their child's sustained interest and continued learning for years to come. The findings also suggest that children's engagement in informal science learning activities could be increased through certain resources and support for the parents that can be accessed on the internet or provided through certain programs. For example, resources that assist parents in recognizing their children's interest-related behavior at an early age might motivate the parents to engage their child in other science-related opportunities.

Children engage in science learning as a result of their personal motivation and also their exposure to opportunities. Holmes (2011) conducted a study designed to explore changes in student motivation and achievement in science during a visit to a local science museum. The participants included 228 6th grade students from a public school, randomly assigned to one of four experimental groups. The four groups were: a control group in which they went to the site, completed the tests and experienced the lesson and exhibits as the other groups did; an exhibit-

only group in which they started their trip by touring the target exhibits with instruction and free time, then completed tests and experienced a lesson; a lesson-only group in which they started with a lesson then took the tests and ended with touring the exhibits, and; an exhibit/lesson combination where they started with exhibit, then attended a lesson, were free to explore and then took the test at the end. Researchers used science achievement tests to measure students' level of intrinsic motivation and achievement in science before the visit to the museum, right after the visit, and another a month later. Results revealed that those children who first visited the exhibits demonstrated a significant relationship between motivational level towards science and quality of learning, as revealed by the achievement test (Holmes, 2011). Results also indicated that children in the exhibit group showed a significant difference in their pre- and post-achievement scores, whereas the other three groups had no significant difference. Experiencing learning through an exhibit, as opposed to just a lesson, proved to have lasting effects for the child's motivation and academic achievement.

Children are more motivated if learning is in an informal, hands-on, exhibit-type learning setting then if it takes place in a school setting. Korpan, Bisanz, Bisanz, Boehme, and Lynch (1997) conducted interviews with 29 parents of preschool aged children and 35 children in grades 5 and 6. Parents of preschoolers responded to interview questions designed to gather information about informal science learning opportunities available to families and communities. The questions aimed at the students explored children's past experiences with science learning. Findings showed that, on average, children are exposed to more than 300 informal science education activities per year - watching science television shows, reading science-oriented books, and visiting museums and zoos (Korpan et al., 1997). Many children reported that they

visited zoos and science museums multiple times a year. Research revealed that in 86% of households, an adult has helped a child with a science experiment or engaged in science related conversations. These findings show how frequently children are exposed to informal science learning opportunities, however, they do not indicate whether and how such opportunities impacts learning and development. There are multiple potential outcomes of informal science learning opportunities, one of which is gaining content knowledge; others include gaining experiential knowledge as well as gaining motivation to learn. In order to know if any learning is truly taking place, several factors, which we will discuss below, need to be explored.

Maximizing the Impact of Museum Experiences on Informal Science Learning

Children experience many types of informal science learning but it is not always clear what they gain from these learning opportunities. Fenichel and Schweingruber (2010) explain that science learning is composed of different strands of learning that are supported by informal environments. The first strand suggests "learners in normal settings experience excitement, interest, and motivation to learn about phenomena in the natural and physical world" (p. 26). The second strand focuses on understanding scientific content and knowledge and the third strand focuses on engaging in scientific reasoning. The fourth strand has learners reflect on science and the fifth strand uses the tools and language of science. The sixth strand wraps it all up by having them develop a sense of identity as someone who knows and understands science. Their book discussed how informal settings help learner's science understanding by focusing on concepts and linking to existing knowledge. Engaging in the scientific reasoning, reflecting on science, and participating in informal environments will increase overall science learning (Fenichel &

Schweingruber, 2010).

Importance of Audience

In order for children to learn in museums, they must first visit. As a result, museum staff has to work to create environments that will appeal to families. Chang (2006) conducted an analytical review of studies focused on the characteristics of museum visitors, their behaviors, and the nature of their museum experiences and learning. He considered the demographics of visitors such as race, age, occupation, socioeconomic status, as well as environmental factors and cultural history. He then explored relationships between demographic factors and behavioral measures such as the time individuals spent in the museum, what aspects of exhibit attracted them, and visitor behavior at the exhibits. He concluded that the more museums consider the social contexts of a region and cultural relevance in their exhibits, the more meaningful the experience was to the visitors. This finding is consistent with Falk and Dierking's (2000) Contextual Model for learning. This model describes four contexts: personal, socio-cultural, physical, and time. This model recognizes that looking at museum learning as "a snapshot in time" is inadequate because "people do not learn things in one moment in time, but over time" (Falk & Dierking, 2000, p. 10). Falk and Dierking argue that museums must work to reflect visitor's voices and personal contexts in the exhibits in order to increase learning, appreciation, and enjoyment for the visitors, which will lead to repeated attendance. Once museums have a better understanding of visitors' needs, they can make more informed decisions about how to create the most meaningful exhibits and programs for their target audience. Generating more audience means gaining more members and, therefore, more support within a community. More support can then be translated into more awareness of the visitor's needs and

desires and more families reached.

Interest and Identity

The child's own personality and interests play a large role in their experience at an informal learning center. According to the Board of National Association for Research in Science Teaching, informal science learning is "learning that is self-motivated, voluntary, guided by the learner's needs and interests, learning that is engaged in throughout his or her life" ((Dierking, Falk, Rennie, Anderson & Ellenbogen, 2003, p. 109). Children are not blank slates coming into a museum, or any situation. They already have developed ideas on how the world works, and have established existing interests that are unique to each individual. So the hope of any learning experience would be to build on top of any already existing interest and knowledge and/or spark a new interest.

Interest when alone. Prior work establishes the importance of the design and social components in supporting children's experiences with museum exhibits, but even the most carefully designed exhibit would not engage a child's full attention if they were not interested. Both Vygotsky and Piaget describe interest as, "deriving from knowledge and value components of what the individual brings to each present action from prior experiences" (as cited in Renniger et al., 1992, p. 362). So, it is the individual who constructs and reconstructs the possibilities for his or her activity. Siach-Bar (1998) conducted an ethnographic study exploring how children construct their experiences while in an exploratory setting. Direct observations over a period of one year designed to understand social phenomena from the participant's point of view produced the data. A questionnaire and several interviews were also conducted to gather more information. After analyzing and coding the data for the children's interactions and the effects of a child's

interest level, several patterns emerged. Children created their own rules to the exhibits and manipulated the objects in ways not originally intended, especially when they were alone. Also found was that play was the driving force behind children's creative interpretation of museum exhibits. Self-motivation, free exploration, and originality described children's actions in play-oriented exhibits. The parents' influence on the child's play was only received when the child felt in control of the activity. This shows that children like to have a say in what exhibits they spend time at, which is influenced by preexisting interests.

Interest plays a particular role in a child's engagement in an activity. Hidi and Renninger (2006) developed a model to depict the development of interest in children and its role in learning. The first phase, triggered situational interest, refers to a psychological state of interest that results from short-term changes in affective and cognitive processing. Triggered situational interest can be sparked by a number of things ranging from environmental, surprising incongruence, even personal relevance (as cited in Hidi & Renninger, 2006, p. 114). The second phase: Maintained situational interest is similar to the first phase. However, it involves focused attention and persistence over an extended period in time, and/or frequent recurrence. The third phase: Emerging individual interest refers to when the individual seeks out engagements with particular subject over times. Individual interest is characterized by positive feelings, stored knowledge, and stored value (as cited in Hidi & Renninger, 2006, p. 114). The fourth and final phase: Well-developed individual interest is the development of the predisposition to re-engage with particular situations relating to certain content over time. This predisposition is typically self-generated but benefit from outside support (as cited in Hidi & Renninger, 2006, p. 115). Hidi and Renninger state "instructional conditions or the learning environment can facilitate the

development and deepening of well-development individual interest by providing opportunities that include interaction and challenge that lead to knowledge building. (p. 115).” They also felt that early situations leading to interest development should involve positive feelings about the activity and informational content about the subject.

Renninger (1992) took a more in depth look at the role individual interest plays in a child’s learning. Renniger reviewed two studies in her book and both assessed the effects of interest on young children’s attention and memory, play with objects, play with others, and temperament. The first looked at 44 children between 2.9 and 4.2 years of age who attended a nursery school. Data were collected using observation, experimental methodologies, or coding or videotapes. The second was conducted with 5th and 6th graders. The questions asked to the students about reading and math had underlying roles of interest, task difficulty, and gender. Results showed that all children had individual interest and non-interests. Those interests can vary from child to child, however; interests and non-interest do affect the way in which children engage and perform on tasks. Younger children interacted with only two play objects out of sixteen while older children played with as many as six. Older children had more interests, or more categories they were willing to spend prolonged periods of time exploring. Showing that over time, children’s interest becomes increasingly diverse. The findings provide strong support for individual interest as having a critical role in the learning and development of both younger and older children. Along with the child’s personal preference, interest can also be sparked in a topic when the subject becomes relevant to the child’s life.

Personal relevance. The Merriam Webster Dictionary defines relevance as the ability to easily retrieve material that satisfies the needs of the user. In order to satisfy the needs of the

user, or in this case the child visiting a museum, relevance must play a part. Many studies reviewed in this paper support the use of relevance in exhibits (Chang, 2006; Fenichel & Schweingruber, 2010; Fusco, 2006; Hale et. al. 2011; Tisdal, 2004; Valle & Callanan, 2006). Chang (2006) stated that it was important that exhibits and programs reflect visitor's personal contexts so that opportunities could be provided to construct connections between museum experiences and the visitor's personal life. In the book, *Surrounded by Science*, Fenichel and Schweingruber (2010), support understanding the connections, similarities, and differences between the ways people evaluate evidence in their daily lives and the practice of science. Once the discrepancies are identified, informal learning centers can develop ways to close the gap. One of the ways they suggest doing that is through incorporating relevance into learning opportunities, such as reading food labels to decide which food items to purchase, or diagnosing and fixing a broken appliance. Tisdal (2004) found that parents prolonged the active engagement for the children and increased their satisfaction level when the parents made relevant connections. Valle and Callanan (2006) further examined the use of rational analogies. Their findings proved that relating past experience's to unfamiliar concepts for a child was a major contributor to their understanding. Both Fusco (2001) and Hale (2011) supported the fusion of a child's past experiences to learning about science topics in the present. This generated new meanings and conceptions more applicable to their own lives, which even furthered the child's understanding. Fusco, as well as several other researches, proposed that one way to combine learning and past experiences to bring relevance to the child's present learning was through the use of gardens. In addition to being relevant to children's lives, gardens also are interactive, can encompass signage/narrative, and can foster a child's interest in science related activities.

Time Spent at Museum / Exhibit

Engagement with exhibits can stimulate visitors' science interest, encourage them to build scientific knowledge and skill, and help them become more confident in their relationship with science. All of this cannot develop, however, if a child doesn't spend much time at the exhibit. As a result, informal science educators and learning researchers have long argued that the amount of time spent at an exhibit is an important indicator of learning. Yalowitz and Bronnenkant (2009) examined the prevalence of researchers use of "time spent at an exhibit" as an indicator of the effectiveness of an exhibit in fostering learning. They reviewed the history of methods to record, analyze and report visitor's behaviors. They found that time spent at an exhibit has become one of the most consistently used methods in exhibition evaluation, perhaps because it is an easy way to establish engagement. Data on duration of engagement with an exhibit may be a reasonable measure of likelihood that learning is taking place. Shettel (1997) found a relationship between the time spent at an exhibit, the amount of that time spent in on-task science-related activities, and the effectiveness of an exhibit in capturing the audience's attention. He concluded that successful exhibits must hold children's focus long enough for them to become engaged in the exhibit's informal science learning opportunities offered at the exhibit. In the following sections, existing understandings of the particular design features that seem to extend and support engagement are reviewed.

Features of Exhibits that Promote Learning Behaviors.

Exhibits can vary greatly in size, form, and content. For example, a simple sign can constitute an exhibit, or an exhibit can be a roomful of material. Different exhibits also engage visitors in different ways. Some exhibits are primarily based on content-delivery through

reading, whereas others involve no reading and are entirely hands-on exploratory opportunities. A variety of studies are now available that can inform museum exhibit developers as they make efforts to design exhibits that will engage children in ways that will positively influence their learning. These studies focus on levels of interactivity, narrative, and signage.

Interactivity. Investigation of the effects of interactive or hands-on exhibits has become a growing focus among learning scientists. Tisdal and Perry (2004) worked with Selinda Research Associates to conduct an in-depth analysis of the features of exhibits that engaged visitors the most. Specifically, the researchers set out to examine visitor engagement at several newly developed exhibits by the National Science Foundation. These exhibits were designed to elicit active prolonged engagement (APE) by visitors at museums. There were two parts to this study. The first compared three APE exhibits to three non-APE exhibits. To collect data, researchers used both qualitative (observation and interview) and quantitative (tracking- and -timing) strategies. They observed a total of 46 visitor groups engage with the exhibits over a period of 5 days: 33 were at APE exhibits and 13 at on-APE exhibits. Of the 46 visitor groups observed, 35 also agreed to be interviewed. Researchers examined five aspects of engagement at the exhibits: time of engagements, physical engagement, intellectual engagement, social engagement, and emotional engagement. Findings revealed that visitors spent a significantly longer time at APE exhibits than at non-APE exhibits and were more engaged in all five aspects of engagement as well.

The next part of the Tisdal and Perry (2004) study focused on the design characteristics that lead to the differences between APE and non-APE exhibits. Data collection proceeded just as it did in the first phase, but with increased emphasis on interviews and observations. The

researchers focused on nine APE exhibits, coding visitor engagement according to the five categories mentioned earlier. They discovered that exhibits that encouraged engagement (in one or more of the engagement types) were able to hold the child's attention for as long 8 minutes whereas exhibits with low engagement only entertained children for about a minute (Tisdal & Perry, 2004). When a parent was present, children's engagement was longer than when they visited alone. Children also expressed greater levels of satisfaction when with parents who made relevant connections between children's past experiences and the exhibit (Tisdal & Perry, 2004). These findings show how the design of an exhibit can encourage engagement physically, emotionally, socially, or intelligently and can greatly affect the child's interaction with it.

Speaker (2001) conducted another study focusing on children's engagement in exhibits of various types. Representatives from 259 hands-on children's museums located in the United States were asked to list their five most successful exhibits based on time visitors spend at the exhibits, the number of participants who use the exhibits, and visitor comments about the exhibits. Almost all of the most successful exhibits (95%-100%) had high levels of interactivity. Speaker (2001) stated "by involving the child in a concrete way with the act of learning itself, the children's museum exhibit encourages the motivation to learn" (p. 613). This finding is compelling as it suggests that no matter what the subject, interactivity leads children to pay attention to exhibits for longer periods of time than they do for exhibits that do not have a hands-on component.

Narrative. Whereas some exhibits have an interactive component, others have a narrative or facilitation aspect, and some exhibits even intertwine both. Lwin (2012) explored the benefits of implementing the use of storytellers into the overall curriculum in museums. The storytelling

performance Lwin examined was held at the Singapore History Museum in a session targeted at 4-to-6-year-olds. Exhibits in that particular section of the museum involved the theme of life and culture for early immigrants from China, who lived and worked along the Singapore River long ago. The institutional purposes of the session were stated in the brochure issued by the museum as " (1) to facilitate the children's understanding of displayed artifacts, and (2) to arouse their curiosity and enhance their knowledge about the life and culture of the early immigrants to Singapore" (Lwin, 2012, p. 230). Lwin both audio-and video-recorded the storyteller and later transcribed the session for verbal, vocal (use of tones etc.), and visual features. The storyteller immediately engaged the audience by having them agree to suspend any disbelief they may have and to participate in a reconstruction of a world the immigrants lived in. Characters introduced were given a background and the general setting was explained. The characters gained more background through the storyteller and audience participation. Then a main action was formed and the audience proposed a resolution. After the story, visitors were then allowed to enter the exhibit and explore. The museum has incorporated characters and other aspect of the story in various sections of the exhibit. In order to see the impact of the storyteller on interaction with exhibits, a control group was observed in the museum, which did not receive the interactive storytelling when entering the museum, and then compared to the observations of the group that participating in the storytelling. Lwin found that storytelling facilitated engagement in various exhibits relating to the story, which as discussed earlier is an important factor in facilitating learning in various ways. The incorporation of the story in exhibits also increased reflection on the culture presented, and promoted more conversations between parents and children about the content of the exhibit. This was in part due to the immediate sequencing of listening to the story

and then exploring the museum, but it also brought relevance to each of the exhibits relating to the story.

Signage: Although having an actual person there to facilitate an exhibit is obviously a desirable influence, as noted in the study just mentioned, it is not always practical for museums. This may be why signage has become a major contributing factor to a visitor's interaction with an exhibit. Museums, in particular exhibits, related to science take the place of a storyteller. In particular, "signage has been identified as a tool for museums to communicate with visitors about the exhibit and to help visitors' meaning-making beyond what visitors can infer on their own from an object" (Kim, 2009, p. 3). Kim examined the role of signage in learning by answering the following research questions, "How does signage about exhibit content or interaction strategies affect parents' and children's learning and their engagement?" and "What is the role of parent prior knowledge on parents' and children's learning and their engagement?" The study looked at 45 parent-child dyads with children aged 6-7 years old. Families were then observed at an exhibit about cars and assigned to one of three conditions: 1) Content and interaction signage, 2) Content only signage, and 3) No signage. Researchers assigned fifteen random families to each condition. Each condition for the exhibit was set up on the floor. Prior to their interaction with the exhibit, researchers evaluated parents' prior knowledge about cars by conducting a pre-interview on their general knowledge about cars. Eight parents had low knowledge on cars and seven had high knowledge in each condition. Findings showed that in all conditions, with both high knowledge and low knowledge parents, engagement with children was higher in the content and interaction signage condition than in any other condition. This shows that parent's knowledge did not play a large factor in their interaction patterns. Results also showed that

parent-child dyads spent longer time at exhibits with either signage condition versus when the exhibit had no signage. Analysis of the conversations between the parent and child found that children and parents learned more in the signage conditions and were able to identify the content of the exhibit more quickly than in the no signage condition. Children looked at signage about 17% of the time while the parents read it to the child. It was also found in a post-interview, that children learned more due to signage, regardless of the parent's prior knowledge, then if there was no signage. Knutson and Crowley (2005) suggest that signage needs to be designed to scaffold interactions around the exhibit so that parents can lead children through more meaningful learning conversations during their visit (as cited in Kim, 2009, p. 4). This perspective acknowledges that the physical design of exhibits is important to their success in promoting learning behaviors and that one consideration to make in exhibit design involves finding ways to promote social interactions.

The Social Context of Learning in Museums

For all visitors, museum experiences are social learning experiences. This is true regardless of the social group who visits together as any individual is likely to encounter others within the museum setting. As a result, museums can facilitate learning by capitalizing on the social nature of learning by encouraging and fostering social interactions with other visitors, parents, and even museum staff.

Parents. Parent-child engagement is a positive and influential factor on the time spent at an exhibit. The more time spent, the more learning can occur. Crowley et al. (2001) recorded information about children's ability to use scientific reasoning and ability to use theories to explain evidence. The researchers specifically focused on the parent-child interaction and how

that influences scientific thinking. The participants involved 91 families visiting a children's discovery museum, with children ranging in age from 4- to 8-years old. Observations from a video camera and microphones set up in the back of an exhibit gathered the information. Children showed a general interest in exhibits on their own, but were only engaged for a short time. When parents engaged with a child at an exhibit, the holding time was longer and children were more focused (Crowley et al., 2001). Children discovered more informational evidence from the exhibits when they were with their parents than when they were with peer groups or on their own. The parents supported their children's scientific thinking through explanations and guiding their child's thinking. Thus, parents played an important role and were able to pursue the conversation and help explain terms and connect previous knowledge.

Valle and Callanan (2006) also found that parents are instrumental in helping children understand science topics and concepts. They extended Crowley et al.'s (2001) work by demonstrating that particular strategies are more effective in promoting science learning than others. They concluded this after conducting two studies examining how the use of similarity comparisons and relational analogies by parents fostered children's understanding on science related topics. Analogies are a comparison between two things, typically on the basis of partial similarity and connections can be created between new experiences and previously existing ones. In Study 1, 98 family groups explored two science museum exhibits. Researchers coded parent-child conversations for any use of analogies and/or efforts to relate the exhibit to the prior experiences of the child. Results revealed that when parents used an analogy or personal connection, children tended to stay longer at the exhibit as well as show more interest than when no analogies were provided. In Study 2, 48 parents helped first- and third-grade children

understand a homework-like question about infections. Researchers tested children before and after the parent-child activity to see if any learning of content had taken place. Findings demonstrated that over 70% of parents made at least one similarity comparison and over 50% used a relational analogy. Further, parental use of rational analogies were the most beneficial conversations for children, no matter what their background experience was in science. The presence of family members affords opportunities for children and families to make personal connections with exhibits and with their lives and experiences outside the museum.

Peers. When consulting children on their experience at a museum, Dockett, Main, and Kelly (2011) found that peer involvement brought children a lot of enjoyment. The Australian Museum recently redesigned and redeveloped an area for children between 0-5 years of age. This new section allowed researchers to develop a study that looked into the child's perception of the new exhibits. The participants consisted of 40 children (16 boys, 24 girls), aged between 6 months and 6 years, and their parents or caretakers. Methods for collecting data included a journal of the child's experiences and expectations at the museum, observations and discussions with children, a space for children to paint or draw what they liked/disliked about their visit, role-playing, and several other strategies for children to report how they felt. The journals proved to be especially helpful in collecting feedback from their experiences. After analyzing all the data, the researchers found a few aspects that seemed to be associated with increased child participation in the museum. The use of real objects seemed to stimulate children as did being able to include friends and family. Children also really enjoyed when an exhibit had some humorous aspect or made connections to their life as depicted in their journals. Seventeen of the children mentioned the importance of including a social aspect within the museum in their

journals. The study revealed a positive correlation between the child's enjoyment and the number of times their family returned to the museum. This study found that consulting with the children and working with them lead to genuine feedback and data which were in turn used to improve the museum. Due to the success of this social experiment on basing the museum curriculum on the child's wants, perhaps it should be studied more to see what other museums can do to incorporate similar aspects in their curriculum.

The Process of Gardening as it Contributes to Informal Science Learning

Gardening is a hands-on activity in which participants can explore many science topics and processes. Further, gardens are very accessible and can be located in schools, at home, in museums, and in community areas. Though there isn't a lot of research on the benefits of gardening in informal settings, the following articles are some that state the goals and benefits of gardening as a means to engage children in science learning.

Benefits of Gardening Programs

Bowker and Tearle (2007) studied the impact of a school gardening program on children's views on gardens and learning. The participants involved 67 schools in India, Kenya, and England, with students ranging in age from 7 to 14 years old. Data collection included four methods: concept maps, drawings from the children, interviews, and contextual observations. Analysis of the data used the depth of descriptions and details in each of the methods. Researchers found that children from each of the countries viewed gardens differently: English children viewed gardens as a place of play and leisure, whereas in India and Kenya the children considered gardens to be more a place of learning and community (Bowker & Tearle, 2007). Despite these differences, the experiences these children had in these school gardens involved

connecting their lives outside of school to the greater community. They learned about certain fruits, vegetables, and trees that grew in their country, and compared them with other countries, as well as how those crops fit into the communities. This study is an example of the impact school gardens have on children's understanding of science and understanding of the process of gardening. The children began to be able to connect what they were learning to what they were experiencing outside of school.

Hands-on, Multimedia, Relevant

A study by Fusco (2001) examined a project also aimed at learning science through a community perspective. The participants of this study included 15 youth, ages 12- to 16-years old. They participated in a nine-month after-school program that operated out of a low-income housing facility. Information was gathered through an "action research approach" which included discussions and evaluations with the participants and also the researchers personal field notes. The findings suggested that science became relevant to the participants when it was demonstrated in a task, in this case, the garden (Fusco, 2001). The participants were able to relate the knowledge of science into something more tangible, more applicable and relevant to their own lives, which helped their understanding and learning (Fusco, 2001). Following the above studies, this is another example of how making science tangible to students, children, or youth will greatly increase their understanding and overall knowledge of the subject.

Being able to relate to a learning experience makes the knowledge and information easier to understand because connections can be made. Hale and colleagues (2011) studied how through direct, relational experience with nature, people are able to generate new meanings to things and create new learning experiences. The participants were involved in a program titled,

"Gardens for Growing Healthy Communities," a collaborative community-based research project that included five core partners. The participants in the research study included 67 individuals ages 25-70 from 28 gardens that participated in individual and group interviews. The interviews included a garden tour and were also tape-recorded. It was found through the interviews that "many expressed an implicit sense of reciprocity between the physical and social aspects of the garden," which included the process of growing food and learning from interactions of other gardeners (Hale et al., 2001, p. 1857). Interviews also revealed that while a lot of ecological learning takes place, the gardeners learn a lot by watching each other, engaging in conversations, and experimenting. The gardeners also revealed a sort of "give-and-take" relationship with the gardener and the plants, as well as among gardeners. They discussed how gardening connects them to their cultural roots, and how feelings of joy and pride come into play for the gardeners when they see their results.

Although the participants in this previous study are older than the targeted age for our project, the findings behind this study are important to note. This revealed the importance that gardens can have in someone's life, and how that can only be experienced through directly interactions. Due to this finding, as well as the others that gave examples of gardening programs, we chose to design an activity that would be project based and experiential for the learner.

Summary

Informal science experiences have many benefits on children's understanding and interest in science. By incorporating everyday experiences children have into an exhibit, science learning will be able to be understood in a context that is relevant to the child. Children understand and become interested in science learning when they are engaged in conversations with parents, get

to share the experience with peers, or if the individual already has preexisting interests. Hands-on and facilitated exhibits have been shown to prolong the child's engagement, directly resulting in a better and lasting learning experience. As mentioned before, when the information is relevant to the child, they understand and show more interest in learning. San Luis Obispo is an agriculturally oriented community and so learning about gardening is relevant to children in this area. San Luis Obispo Children's Museum lacks a program to informally teach children about science through plants. The project description that follows aims to address this gap in museums curriculum. It will provide a means for informal science learning to be taught through a relevant hands-on activity relating to gardening that will involve parent-child engagement

Methods

In order to look at how children learn in informal settings, we created a one-day interactive workshop. We titled out workshop, "Little Farmers," which was held at the San Luis Obispo Children's Museum. It included an interactive gardening activity, where the children and families had the opportunity to learn about plants and the science processes involved. All activities focused on generating parent-child interactions as a way of engaging the child and fostering more learning. Families could pick and choose which activities to partake in. Potted seeds, brochures, and storybooks were all available for families to take home to continue the learning process and bring relevance of the project into the child's life.

Participants

The targeted audience for this activity was children ranging in ages from 1 to 10 years of age and their families. To attract families to the activity, we advertised in the museum newsletter, as well as via flyers on display at the entrance of the museum. We also passed out flyers to some

classrooms at Bishops Peak and Teach Elementary School, along with businesses around town such as coffee shops and toy stores. Approximately 20 families went through our exhibit over a period of four hours during the day of the activity. Each family included either one or two guardians and one to four children. The ages ranged from about 2 years to 10 years of age and was a random mix of male and female.

Procedures

We created a set of interactive activities to teach children about science processes and demonstrate the relevance nature had in their lives. We titled the program "Little Farmers." We designed activities that would engage children but also facilitate parent-child interactions. Our activities provided participants with opportunities for hands-on learning because this leaves a more lasting impression than learning in formal settings (Tisdale & Perry, 2004; Speaker, 2001). We specifically wanted to teach children about science through the informal process of gardening and parent-child interactions, and wanted to build up the efforts of a prior Child Development student who created a garden at the museum. One lesson learned from the prior senior project effort was that having a garden at this particular museum was unsustainable due to staffing considerations. Learning from this previous senior project, we designed something that would be able to be sustained after we leave, if the museum chose to do so. With this goal in mind, our aim was to have this activity take place monthly so that the museum staff would be able to maintain it and so that it would draw a bigger audience.

The "Little Farmers" activity that we produced was a one-day event that took place at the San Luis Obispo's Children's Museum. It took place on Saturday, February 1st, from 10:00 AM until about 1:30 PM. We set up in an outdoor picnic area that is partially covered by a balcony.

We arranged the various activities in a semicircle with breaks in between each activity (see Appendix, Figure 1). Below we describe the main activities offered in the Little Farmers activity.

Welcome table. There was a table front and center as people walked in with various handouts and information displayed on it. We made the following materials available at the entry table: a parent's guide to our activity, brochures on how to continue engaging children in gardening at home, and evaluations of the project (see Appendix, Figure 2).

Seed planting. Next to the welcoming center, we set up a table with the seed planting materials. The table displayed signs stating, "grow" and "plant" to label the activity. Packets of all different seeds were laid out on the table so the children could choose which one they liked best (see Appendix, Figure 3 & 4). Seeds were donated from San Luis Obispo Farm Supply and the soil was donated from Sage Nursery. Beside the larger table was a smaller table full of soil for the children to scoop up the dirt and feel it with their hands. We provided them mini clear blue plastic cups to plant their seed in, as well as popsicle sticks to label what seed they planted. We also displayed a few jars with some seeds that we planted the weeks prior to event. Seeds were in the germination stage (1 week and 2 weeks in) as well as in the stems and leaves stage. This way the children could observe the different real-life stages of growth with their own eyes. We also placed flowers and herbs borrowed from Home Depot and Growing Grounds Nursery on the table to encourage their exploration.

Photo opportunity. Beside the planting station was a photo opportunity for families to use to remember the event by. It was a cardboard stand up that had cutouts for the parents and children to place their heads that displayed them in a garden scene (see Appendix, Figure 5).

Reading station. Next to the photo opportunity there was a table with the sign "learn" on

it, which had a stack of books checked out from the local library. Storybook reading was shown to promote children's engagement if it was relevant to the activity (Lwin, 2012). Even more plants were set on this table so that children could touch, smell, and look at (see Appendix, Figure 6 & 7).

Game station. Following this station was our game center. A table with the word "play" on it had a matching game set up and a plant cycle growth game. This game was comprised of a plant cycle poster board, matching game pieces, and a circle drawn with chalk on the ground that was divided up into 6 sections. The goal was to match the game pieces to the corresponding section in the circle. This was in an effort to see if children understood the order of the plant process (see Appendix, Figures 8 & 9).

Blank booklet station. We labeled out last table with a sign that said "create." Mini blank storybooks and markers were laid out for children to draw either plants in the surrounding area or to keep track of their plant's growth (see Appendix, Figure 10). There were more plants on display for the children to observe, touch, and smell as well and some even with labels encouraging the children to do so.

Signage and decorations. Surrounding the entire area, open-ended questions were posted on the walls to facilitate parent-child interactions by engaging in conversations about plant processes the natural world surrounding them. To create a finished look for the outdoor area, bunting with fabric and paper scraps were hung from the ceiling.

Take home materials. We created a brochure for parents to take home aimed at facilitating conversations about the plant and discussions about everyday encounters with nature (see Appendix, Figure 11 & 12). It also provided additional activities, such as a soil test

experiment to see what additions to the soil would be needed if they wanted a perfect gardening soil. There are also references for online resources that could help facilitate discussion and activities for children and their families. Fun facts were written in sporadically to make the brochure an easy and fun read for the parents and children to do together.

We consulted with Dr. Jennifer Jipson, a professor at Cal Poly, who specializes in children's informal science learning, on various aspects of the project. She guided us through the proper processes of executing a museum quality exhibit and on aspects such as correct wording and framing of questions. We also consulted with the Children's Museum Director of Operations and Guest Services, Sheryl Flores, to share ideas and get feedback about what she has seen to work best in her experience.

Exhibit Evaluation

We evaluated our project through observations and through brief evaluations with parents and staff of the museum. The observations included taking brief notes during and after the event to record what went well and what didn't, tallying totals for each activity, and noting how people are responding and interacting with the various centers. We asked families as they left the area to fill out a brief evaluation of seven questions so that we could have feedback on their child's experience as well as their own (see Appendix, Figure 13). We also created evaluations of five questions for the museum staff to fill out so that we could get feedback on their opinions of the event and how successful they felt it was (see Appendix, Figure 14).

Results

Results are discussed in terms of the number of families that visited and our assessment of their behavior at the activities. The first part of the results section displays our findings of

what occurred during the event and the second part reports findings from the evaluations.

Results from Observations

***Seed planting*.** We found that the seed planting activity was the most popular of all of our available activities. Children and their families were the ones who explored this opportunity the most, with the parents guiding discussions of how to plant the seeds and the growth process the seed goes through to become a plant. All 15 of the evaluations filled out by parents listed their child's favorite activity being planting, watering the plants, or playing in the dirt.

***Photo opportunity*.** The photo opportunity was engaged by some children on their own, but most engaged as a whole family. Most children were excited to pose in the garden scene and then to see the photo taken.

Blank book. Visitors also engaged in the coloring book we provided and mainly children chose to take part in this activity. We had children who drew different stages of the plant's growth, as well as children who drew the plants displayed around the activity area. Two parents listed this activity as one of their child's favorites, along with the planting activity.

Matching game. We displayed the matching game on the table with the plant cycle game as well. No children engaged with the game on their own, but one parent flipped through the matching cards.

Plant cycle game. We displayed the plant cycle poster on an easel, drew a circle on the ground with numbers one through six in it, and displayed the different plant stages on a table. No children or parents engaged with this activity.

Reading. We checked out books on plants, gardening, pollinators, and seeds from the local library and displayed them on a table with some chairs. Two children picked up a book and

flipped through the pages, looking at pictures but not reading. No others chose to participate in this aspect of the activity.

Questions. We had questions displayed around the area on the walls that had the goal of the parents engaging their children in conversations. A few of the parents noticed the questions and started asking their child the questions, as well as adding some of their own. The children who were asked questions responded positively and showed more interest in the activities, as well as starting to ask their own questions. Most parents didn't ask the questions.

Results from Evaluations

Family evaluations. We obtained evaluations from 15 families on the day of the activity. Fourteen parents either "strongly agreed" or "agreed" with the statements that "The activity taught my child something new" and "This activity encouraged me to engage with my child." Fifteen parents strongly agreed or agreed with the statement, "I learned new ways to explore nature with my child," as well as with the statement "The handouts/supporting materials contained material I'm likely to refer to in the future." Nine parents stated that their child was "very interested," five parents stated that their child was "interested," and one parent said their child was "somewhat interested."

There was space left for parents to comment and provide suggestions. The statement "Lots of opportunities available" was mentioned six times and one suggested making the activity a regular part of the museum offerings. One evaluation stated it was nicely laid out for "short attention people." Some suggestions were to have more explanation for why we plant and its benefits for older children, as well as to have a box of worms for children to play with as well.

Museum evaluations. Three museum staff members filled out an evaluation for the

activity. Two strongly agreed and one agreed with the statement "This activity would be worth having again," as well as with the statement "The children learned new information about gardening," and with the statement that "The information and materials were relevant to families" as well as the statement "The activity fostered parent-child interactions." All three evaluators strongly agreed with the statement "The presenters communicated and engaged well with the families."

There was space for comments and suggestions at the bottom of the evaluations. They suggested putting the activity in a more sheltered location, out of the wind and in a warmer location with fewer distractions. They also made a comment that they noticed children getting distracted by other things surrounding the workshop, and if possible, to reduce distractions, although most admitted that this wasn't a huge problem.

Discussion

We designed the "Little Farmers" project to teach children about science in an informal setting through the use of a gardening activity that would both engage children's interests and facilitate parent-child interactions. Several activities were consistent with the findings in the research we looked at, while others didn't support the findings, however, that may be due to other factors.

We found that the majority of children and families enjoyed the seed planting activity. This could be due to the hands-on aspect as well as the parent-child interaction that accompanied the activity. Being able to physically interact with the seeds and the dirt stimulated interest in the form of questions and supplemental ways of interaction (Speaker, 2001; Tisdal & Perry, 2004). For example, children started to water the dirt after learning that it was a part of the growth

process for a plant. Other children also started watering the plants on display around the rest of the workshop. This revealed that children were forming connections between the relationship of seeds and plants. Parents engaged their children the most during this activity through questions and descriptions of the growth process. Some parents discussed ways to relate the plant growth process to their child's lives. For example, stating that the fruit they eat came from a similar seed that they are planting. This shows that parent-child engagement is a positive and influential factor in children's learning (Crowley et al., 2001; Valle & Callanan, 2006).

We chose to include the reading station activity as well as the coloring book activity to bring in a narrative aspect of learning, which has been shown to facilitate engagement in exhibits (Lwin, 2012). However, these findings included a facilitation aspect, while ours was self-guided. This led to a lack of interest and low response to these activities. When the parents did facilitate interaction with the coloring activity, children participated and seemed to enjoy the creative aspect. The reading station lacked participation, which is likely due to no facilitation or opportunity for interaction. This activity may have benefited from a storyteller reading the books and a more interactive aspect of reading (Lwin, 2012).

Signage was shown to be a contributing factor of visitor's interaction with an exhibit (Kim, 2009). We had open-ended questions displayed around the workshop to scaffold interactions of the parent-child relating to the activity. Some parents chose to read the signs themselves, but only a few chose to actively engage their child in the questions as well. Previous research found that when parents engaged their children with relatable connections to past experiences, the most beneficial conversations for learning took place (Valle & Callanan, 2006). This proved to be consistent with what occurred during the "Little Farmers" workshop. Parents

that did engage their children were able to foster a better understanding on the plant growth cycle in their children.

We chose to include games to make the exhibit more interactive for children that provided a different way of learning (Speaker, 2001; Tisdale & Perry, 2004). Yet, the games we designed and had displayed also didn't get any attention. The lack of success of the games may be due to the fact that there was no facilitation to initiate the playing of them or that they were not age appropriate. The majority of the child visitors were below our intended target age. In order to see if our games would be beneficial for learning in a different setting with an older audience, we did an impromptu activity with a local Girl Scout troop at their regular meeting. We invited the girls to each wear a picture of a different stage of the plant growth on string around their neck. We didn't display the poster showing the actual plant cycle and asked the girls to line up in order. They did so with no trouble and said it was easy to do. We then asked a few of the girls who were interested to participate in the matching game. We described that the goal was to match the seed with the plant and that there were fun facts on the backs of each card. Pairs of girls worked on the matching game and solved it with ease, using the names on the backs of the cards to help them when they were stuck. They said it was fun and one girl even tried it again to see if she could do it faster. Due to the positive response of the Girl Scouts using the games, we concluded that these games would be effective with an older audience and with some facilitation, similar to the reading and coloring book stations.

We chose to have our workshop take place at the San Luis Obispo Children's Museum because of the informal nature of learning that occurs there (Bell et al., 2009; Korpan et al., 1997). Previous research has shown that informal learning opportunities provide a place for

children to actively engage in learning and create their own understanding (Fenichel & Schweingruber, 2010). Opportunities such as these lead to development and interest that can drive a child to learn more about the subject (Alexander et al., 2012; Dierking et al., 2003; Hidi & Renniger, 2006).

The museum itself may have been a distracting location to have an additional activity due to the amount of exhibits and other activities for children to do. Even though this is the nature of informal learning, to have a free-choice environment, this caused low interest in our workshop. This could have been due to the activities not being compelling enough and the fact that many options existed for the children. Suggestions were made by the museum staff to have the activity in a less distracting area and one that was more sheltered since it was a cold and windy day. They shared how they have had difficulty with engagement at their own additional activities in the museum.

If the museum decides to continue on with the activity or if it were to be done again, there are a few changes that we recommend. First of all, the location needs to be in a place that has fewer distractions. “Little Farmers” is designed to be more of a supplemental activity as opposed to a stand-alone attraction. We thought about maybe having a booth at the Farmers Market downtown, at a school’s open house, or some other event where the whole family would be in attendance. All these places would allow for the parent-child interactions and all take place in informal learning settings. There also needs to be more facilitation for some of the activities. We gave the parents a guide for what was available at each station, but having a point-person at each station would help for any questions and to draw people’s attention. The games would definitely need a guide to initiate play, and having someone at the planting station would also be

helpful. All the stations would benefit from more facilitation in general.

In sum, our goal was to produce a hands-on interactive learning opportunity that took place in an informal setting where learning was enhanced by parent-child interactions. We found that parent-child interactions were strong during this activity, which was consistent with what research has found (Crowley et al., 2001; Valle & Callanan, 2006). The project was a success based on that goal, but has room to grow and improve with the suggestions above. When wanting to teach children new knowledge, consider the benefits of involving parents in the learning process and realize that learning can take place out of the formal classroom setting.

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Appendix A

Figure 1. Panoramic view of Little Farmers activities.

Figure 2. Welcome table with displayed brochures, evaluations, and parent handouts.

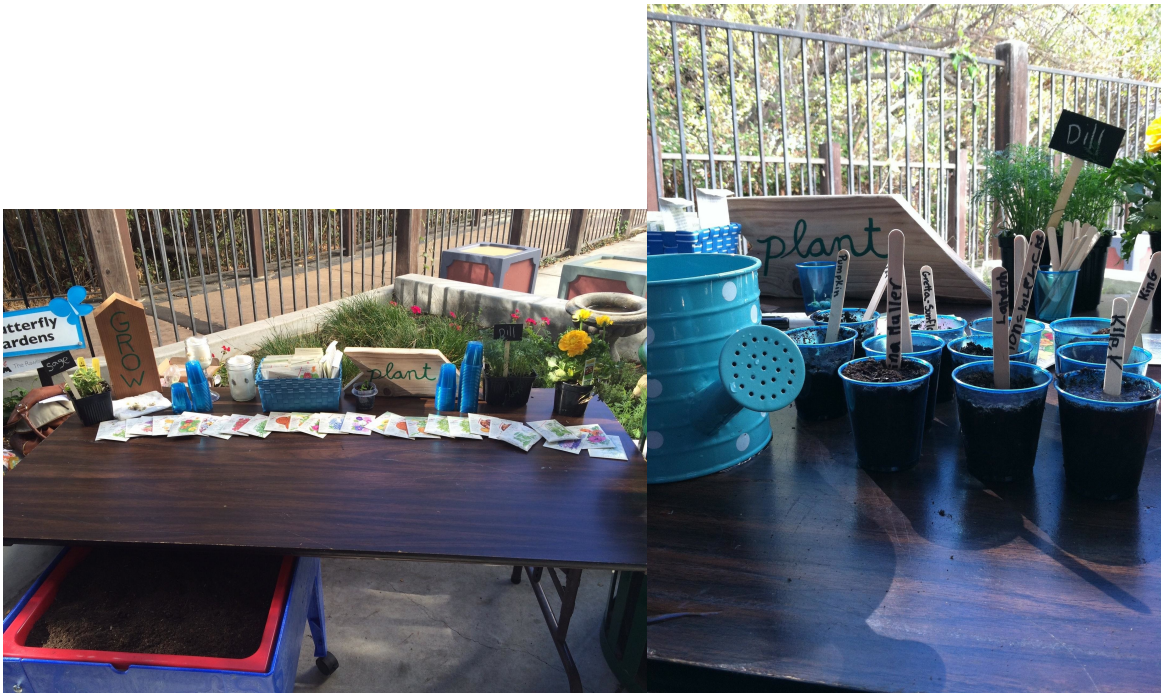


Figure 3 & 4. Seed planting activity.

Figure 5. Photo opportunity.

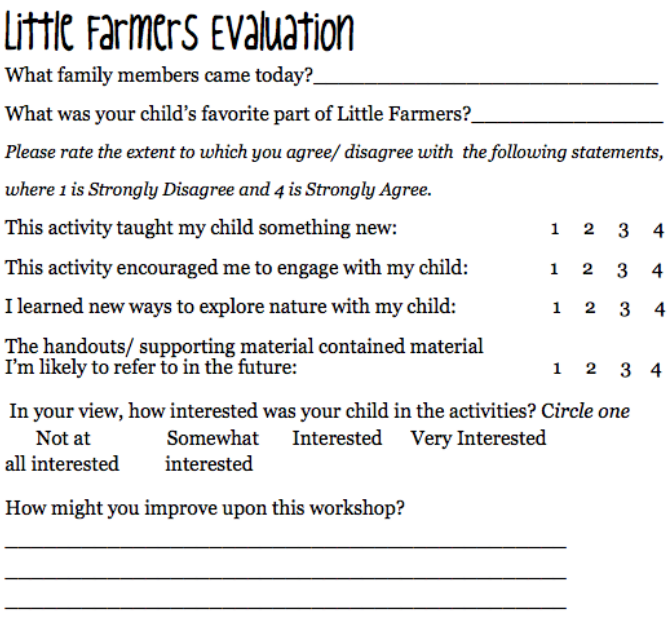
Figure 6 & 7. Reading and Plant Observation activity.

Figure 8 & 9. Game center (plant cycle game and matching game).

Figure 10. Blank Story Book activity.

Figure 11. Front of Parent Brochure.

Figure 12. Back of Parent Brochure.



Little Farmers Evaluation

What family members came today?_____

What was your child's favorite part of Little Farmers?_____

Please rate the extent to which you agree/ disagree with the following statements, where 1 is Strongly Disagree and 4 is Strongly Agree.

This activity taught my child something new: 1 2 3 4

This activity encouraged me to engage with my child: 1 2 3 4

I learned new ways to explore nature with my child: 1 2 3 4

The handouts/ supporting material contained material I'm likely to refer to in the future: 1 2 3 4

In your view, how interested was your child in the activities? *Circle one*

Not at all interested | Somewhat interested | Interested | Very Interested

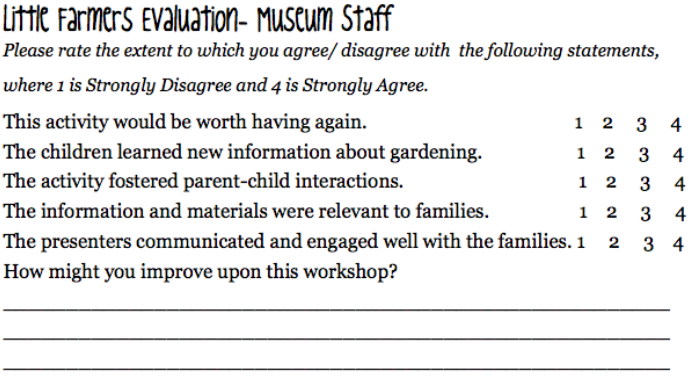
How might you improve upon this workshop?

_____

_____

_____

Figure 13. Parents Evaluation form.



Little Farmers Evaluation- Museum Staff

Please rate the extent to which you agree/ disagree with the following statements, where 1 is Strongly Disagree and 4 is Strongly Agree.

This activity would be worth having again. 1 2 3 4

The children learned new information about gardening. 1 2 3 4

The activity fostered parent-child interactions. 1 2 3 4

The information and materials were relevant to families. 1 2 3 4

The presenters communicated and engaged well with the families. 1 2 3 4

How might you improve upon this workshop?

_____

_____

_____

Figure 14. Museum Staff Evaluation form.