

# Encouraging parental guidance for young children's learning in science through an outreach program in playgroups



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## Abstract

This article explores the impact of an outreach program into community playgroups on parents' role in promoting young children's (3-4 years old) engagement with science. We employed a mixed-method research design to study parents' perceptions of the impact of their participation in a science-based outreach program on their awareness of the everyday nature of science, and their inspiration and confidence to engage with their children in science. Data were of two kinds: a baseline questionnaire administered immediately after the outreach program to 465 parents and observation of 15 parents with their children during the program, followed by interviews at one or two weeks and seven weeks after the program. Quantitative and qualitative analyses of this combination of coarse- and fine-grained data suggested that even though parents were initially interested in science and comfortable supporting their child's play, they believed that participation in the science outreach program enhanced their understanding of how their child learned. Parents became more aware of their child's interest in science, the everyday opportunities for learning science through play, and began to seek opportunities to promote science-related experiences with their child. Implications are drawn for how informal science educators can assist parents to understand their role in encouraging children's explorations in science.

**Keywords:** Early childhood education, science outreach, parents' perceptions, scaffolding children's learning

Young children play to make sense of their world. They play by constantly exploring and experimenting within their social, cultural, and physical environments; activities that are crucial to their early learning and development (United Nations Committee on the Rights of the Child, 2006, Para 34). Creative play and exploratory learning are fundamental to the development of concepts about how the world works and thus the beginnings of understanding science. The position statement from the National Science Teachers Association for Early Childhood Science Ed-

ucation (NSTA, 2014) declares that “these are basic abilities for science learning that can and should be encouraged and supported among children in the earliest years of their lives” (p. 1). Further, the NSTA position statement for Parental Involvement in Science Learning records that “parents and other caregivers have a critical role to play in encouraging and supporting their children’s science learning at home, in school, and throughout their community” (NSTA, 2009, p. 1). In other words, young children’s explorations of their physical environment are inherently science-related; they lay the foundations for the later development of science concepts, and parental support is central to this process. How do parents provide such support?

Families are the fundamental learning unit for children from birth, providing learning opportunities both inside and outside of the home environment. To support their child’s learning about science, parents must recognize that many of these opportunities are science-related and know how to engage their child in ways that promote scientific thinking. One particular kind of engagement outside of the home, before the children begin formal preschooling or kindergarten, is participation in community playgroups. In this article we explore how parents’ participation in a science outreach program that visited their community playgroup impacted on their subsequent behavior in promoting their young children’s engagement with science.

Community playgroups are informal, voluntary gatherings of young children (with their carers, usually parents) aged from birth to about 4 years, before the children begin formal preschool or kindergarten. Playgroup attendance provides social opportunities “for children to interact with and engage in play with similar-aged children on a regular basis in a safe environment, ...[and]... provides caregivers with the opportunity to strengthen social networks, parenting skills, and knowledge of their child’s development” (Sincovich et al., 2019). They are usually held in a community venue, and most have a large supply of indoor and outdoor toys. The degree of structure in the activities varies from playgroup to playgroup, according to members’ wishes. An analysis of playgroup attendance (Sincovich et al., 2019) indicated that just over a third of Australian children attended a playgroup before starting school. Attendance was proportionally lower for children who lived in areas of socioeconomic disadvantage, had a non-English language background, or were First Nations children, although these gaps were slowly decreasing.

Very little research has examined parent-child learning in community playgroups. In a recent review of playgroup participation (McLean et al., 2020), a literature search using the term “playgroup” and several synonyms identified 3,879 potential records, but after screening, only 5 met the criteria of community playgroup, reporting empirical investigation, peer-reviewed and English language. McLean et al. reported on the benefits for mothers, children and the community of playgroup attendance and barriers to meeting those benefits, but none focused on science.

The science outreach program in this research (referred subsequently as the Outreach) comprised a variety of interactive science-related exhibits and other activities accompanied by two presenters. The Outreach visit disrupts the usual playgroup routine by offering children new activities for exploration and learning and, importantly, new opportunities for parents to assist them to learn. By inves-

tingating parents' responses to the Outreach and its activities, we aimed to identify features that can assist parents to engage their children in science-related play at home, beyond the Outreach experience.

In the following sections we overview the role of parents in supporting science learning through their child's play, then describe the theoretical perspective that underpins our research. Following the development of the research questions we describe the context of the study and our research design. The findings are presented and interpreted with implications drawn for outreach presenters.

## Parents' Role in Supporting Learning of Science through Play

In a family environment, parents support and extend young children's learning by facilitating play, mediating play experiences, and by direct involvement through co-playing or play tutoring (Dockett & Flear, 2002). There are many opportunities for parents to interact with their children and promote their learning in similar ways outside of the home, in places that offer support for children's play, such as parks and nature trails (e. g., Uzick & Patrick, 2018), science centers (e. g., Marcus et al., 2018), and museums (e. g., Callanan et al., 2017; Dooley & Welch, 2014). Much of our understanding about family learning and children's play has developed through research in these places because families are the most common visitor grouping. Here, research is facilitated because, without the distraction of other daily activities of family life, the nature of parent-child learning interactions becomes more visible, and data collection is less intrusive than in the home.

Research in this field began with observation of families in museums and science centers. Seminal research by Diamond (1986) and McManus (1994) identified the ways families supported each other's learning; for example, parents frequently acted as exhibit interpreters for children, by pointing, asking questions, and modeling exploratory behavior. Dierking and Falk (1994) reviewed the field and recognized that "family learning involves both cognitive and affective domains and appears to be socially mediated" (p. 68). When Haden (2010) synthesized research about parent-child science-related talk in museums, she noted the trend over previous decades to a sociocultural perspective, emphasizing that understanding learning requires focus on the process of learning. By attending more closely to the nature of parent-child conversations, researchers could reveal how parents assisted their children's scientific thinking (Ash, 2003). For example, Crowley et al. (2001) observed 91 families in a science center and found that when parents supported their 4- to 8-year-old children's scientific thinking through assisting them to identify, generate, and interpret evidence when using a science exhibit, children's engagement was longer and more focused than if they engaged alone. Fender and Crowley (2007), working with 5- to 7-year-old children, concluded that procedural assistance in using an exhibit is more important in encouraging exploratory behavior than providing explanation of how it works. Szechter and Carey (2009) reported that parents and their 5- to 15-year-old children spent more time at exhibits designed to support experimentation and choice in order to encourage active, prolonged engagement, than those that simply demonstrated phenomena. Their research with 20 parent-child dyads identified parents' "learning talk", including describing evidence, giving directions, providing explana-

tions, making predictions, and connecting with past experiences.

References to past experiences to aid sense-making has been noted in science centers (e.g., Zimmerman et al., 2010) and museums (e. g., Geerds et al., 2015). McClain and Zimmerman (2014) analyzed family conversations at a nature center to determine how the use of prior experiences shaped family talk. Parents and children (aged 1 to 15 years) reminded each other of past activities, using them to prompt knowledge-sharing and to clarify and refine explanations. Callanan et al. (2017) explored the science-relevant conversations of 82 families with 3- to 11-year-olds children and drew attention to the need to study children's thinking in real-world contexts. They found that parents who tried to connect exhibit content to children's prior knowledge and experience were more successful in engaging their child's attention and interest.

Eberbach and Crowley (2017) examined the conversational strategies of 79 parents and their children aged 6 to 10 years while learning about pollination in a discovery garden. They used an intervention to help half of the parents improve their use of elaborative conversational strategies and the other families used their natural conversational style. They found that parents asking *wh-* questions helped children to notice details but, overall, it was the increase in science-related talk together with children's prior knowledge that determined the learning that occurred. *Wh-* questions refer to questions that begin with words like *what*, *why*, *where*, *how*, that prompt thinking.

Research by Franse et al. (2020) with 8- to 12-year-old children in a science museum demonstrated that parents who had pre-knowledge about an exhibit were more likely to use scaffolding behavior. They asked their children more questions, explored longer, and more often interpreted results than parents without pre-knowledge. If parents lack specific content knowledge, they may miss opportunities to assist their children's understanding (Knutson & Crowley, 2010), but even if they cannot explain exhibit phenomena, there are still opportunities for parents and children to learn together. Ash et al. (2007) have shown that families do not need to use scientific terminology in exhibit exploration, they can talk about and make sense of science using everyday language. Her "study strongly advocates for the importance of everyday talk in science learning" (p. 1598), and we argue that when working with very young children, "learning talk" (Szechter & Carey, 2009) often needs to be everyday talk.

The notion of "learning talk" in family conversations draws attention to the nature of language used and by whom. Young children have a more limited vocabulary than older children, they may converse less, and it might be expected that parents converse with them in a different way. Geerds et al. (2015) explored the kind of information 64 parents provided to 76 children at biological exhibits. The authors compared parent talk with preschool children (average age about 4 years) and school-age children (average age just over 6 years) and reported that parents referred to visible animal features or made connections to existing knowledge or prior experiences equally to each group. However, parents with preschool children made more conceptual, interpretive comments and anthropomorphic statements than did parents of school-aged children. Geerds et al. also found that parents initiated about four times as many biological utterances as did either group of children.

In contrast, when Dooley and Welch (2014) observed adults interacting with

30 children aged 1 to 9 years in a children's museum, they found that adults and children led the interactions equally. Dooley and Welch did not separate their data based on children's age and the greater degree of children-led interaction may be an age difference, but it is more likely to be related to the freedom of hands-on museum activities compared to the look-and-see nature of zoo exhibits studied by Geerdts et al. (2015). Dooley and Welch found that children mostly led by "show and tell", drawing attention to what they were doing or to specific objects, or by asking questions or requesting assistance. They refocused the activity by walking away. Most adult-led interactions could be described as teaching: explaining, commenting, prompting, or "playing along" with their child(ren) (p. 130).

There are very few studies of the long-term effects of family interactions in informal environments on either parents or young children, partly due to the difficulty in contacting people and the associated low response rates. Oxarart et al. (2013) surveyed adults in families visiting a play area in a zoo that was built to mimic local habitats. Oxarart et al. did not report children's ages, but the activities in the play area were suitable for young children. Parents considered their children's play experiences to be active, imaginative, and educational, and these positive perceptions of their children's play persisted 2-4 weeks after the visit. Parents also indicated increased interest in taking action, caring about, and visiting a local natural area as a consequence of their visit.

Idema and Patrick (2019) found that three months after visiting a science festival with marine-related activities for visitors, parents in five families remembered themselves mostly as onlookers in the activities, but their seven children (aged 6 to 10 years) remembered their personal interactions with staff and exhibits in considerable detail. Idema and Patrick distilled seven characteristics for designing experience and activities that could promote meaningful learning experiences for families.

In another family-based study, Briseno-Garzon et al. (2007) investigated adults' learning outcomes from family interactions while visiting an aquarium. Two to three weeks later, the 13 participants still believed they had gained knowledge relating to the exhibit, a better understanding of their children's learning characteristics and behaviors, and developed a range of emotions and values associated with the aquarium. These studies highlight the role of adults in family groups as active learners rather than mere facilitators of children's learning. Adults may not see themselves as learners, yet there are many opportunities for them to learn not only from the exhibit, but perhaps more importantly, about their children's capacity for learning. In a 6-month longitudinal study of mother-child conversations at home about camping and bird-watching, Hedrick et al. (2009) found that the initially 3-year-old children remembered more of their experiences during events when they answered their mothers' *Wh*- questions with the correct requested information. Hedrick et al. found that at age 3 years, children responded correctly to their mothers' questions half of the time but about a quarter of the time they did not respond at all. Children responded more frequently as they became older, and those whose conversations with their mothers were characterized by high levels of joint verbal talk were more likely to retain information. These authors concluded "it seems likely that what children gain from their engagement in joint conversations during events may be the means by which children construct elaborate representations of these experiences, making them more available for

future memory narratives” (pp. 159-160).

The research cited above shows remarkable consistency in what parents can do to support their child's learning in play. Riedinger (2012) summarized the outcomes of family research and drew up a list of strategies parents could use to encourage the participation of young children in exhibit exploration and promote their learning. Key strategies are open-ended questioning, probing children's understanding, pushing them to explore further and extend their thinking, and modelling exploratory behavior.

## Theoretical Background to this Research

Consistent with much of the research cited above, we take a socially constructed perspective on learning. The developmental psychologist Piaget and sociologist Vygotsky laid the foundations for understanding learning through the theoretical perspectives of constructivism and socioculturalism. Constructivism recognizes that knowledge is constructed when individuals make meaning by connecting experience and ideas and that meaning is continually refined as it is tested by new experiences. From his work with children, Piaget (1929) suggested that learning develops from the concrete to the abstract, and young children's exploration of their environment is fundamental to the development of more formal, conceptual understanding. Sociocultural theory owes much to Vygotsky's (1978) belief that learning, indeed all human activity, takes place primarily in social and cultural settings in which people communicate through interacting with each other and exchanging ideas. From Vygotsky's perspective, children's play is socially situated and the nature of learning is dependent upon the context. Social constructivism focuses on how meaning is constructed in dyads or small groups. Thus, as Harlen (2013) pointed out, “there is a constant to-ing and fro-ing from individual to group as knowledge is constructed communally through social interaction and dialogue. Physical resources and language also have important roles” (p. 31).

Of particular significance to our perspective in this paper, is Vygotsky's notion of the Zone of Proximal Development; that learning is promoted when the learner interacts cooperatively with others who are more knowledgeable and can scaffold the learner's thinking to a deeper level of understanding. In this research, our focus is on the parent as the more knowledgeable other, who can introduce a new idea, or assist with a skill as a scaffold to enhance their child's learning. As Schauble et al. (2002) and others have pointed out, this does not happen automatically; parents need to recognize when and how they can scaffold learning.

We remarked earlier on the consistency in what parents do to support their children's exploration and engagement in science-related activities. They are scaffolding their children's learning. Scaffolding behavior includes modelling, thinking out loud, asking more open-ended *Wh*- questions, instructing or giving hints about what to do or look for, and interpreting or explaining to help children make meaningful connections about content and experience.

However, even parents who value and actively support play may not know how best to support their children's science learning. Geerds et al. (2015) noted that parents often missed opportunities to expand on children's simple biological explanations, a feature noted by Schauble et al. (2002) with older children. Schauble et al. interviewed 32 parents and discovered that 44% of them believed that

simply interacting with exhibits would lead to learning and the best role for adults was to stand back. Although 28% of parents believed that play alone was insufficient to support their children's learning, they were unsure how they could help. Only 13% suggested asking 'how' or 'what if' questions, and only 9% mentioned modelling.

It is also possible that parents do not recognize the opportunities for learning that may be present in exhibits, even those designed for children. Song et al. (2017) found that parents were less likely to see learning opportunities for children aged 2 to 10 years than experts trained in child growth and development. Song et al. found that additional signage on exhibits increased parents' ability to see the potential for children's learning.

We found little research designed to help parents learn how to support children up to the age of 4 years, as most research focuses on preschool or school age children. Van Schijndel et al. (2010) used a short video to "coach" parents to help their 4- 5-year-old children explore exhibits at a science center. The coaching techniques scaffolded children's engagement by helping them to explore the exhibit, using open-ended questions to investigate how the exhibit worked and what it could do, then encouraging the children to draw conclusions about what they had discovered. The results indicated that parental coaching led to increased active engagement and exploratory behavior. It seems that parents can be helped to perceive learning opportunities and to develop scaffolding behavior. But do these behaviors continue into everyday activities at home? Although pre-knowledge about science is important, it is not practical to teach parents science content, because they will cover an unknown range of topics. It is more important that they learn to recognize the opportunities for science in the everyday and, rather than be "put off" if they lack confidence in science, appreciate that they can learn together with their child.

Based on the research reviewed here and our theoretical perspective, we suggest that parents are best placed to assist their young children to develop scientific thinking and communication skills in science-related explorations when they are aware of science in their everyday activities, are interested in science, are motivated or inspired to assist their child, and have the confidence to do so in science-related situations. One way to help parents to develop these strengths is through science-related outreach, an approach so far untested.

## Research Focus and Questions

There is little research literature about family behavior during outreach activities, particularly for preschool children, yet these experiences provide opportunities to refer to, reflect about and, importantly, build on the learning experiences offered by the outreach activities. Apart from the additional opportunities to learn through "rehearsal" of those experiences (Rennie, 2014), learning can be extended as it is contextualized in new, related experiences beyond the visit. Longitudinal studies that explore the post-visit activities parents may pursue at home with their children are also difficult to find.

To illuminate this under-researched area, we explored parents' perceptions of the impact of their participation in a science-based outreach program on their understanding of how to assist their child's learning through play. This paper reports part of a larger, longitudinal study of the effects of science-based outreach into

community playgroups. The research had two strands: The first strand focused on the children and investigated the nature of children's engagement behavior with the Outreach activities, and the relationship of that behavior to their understanding about the exhibits. The findings of this first strand are reported in Rennie and Howitt (2020) and Howitt and Rennie (2021). The second strand, reported here, focused on parents and explored how best to increase their interactions with their young children (aged 3-4 years) that build interest and engagement in science that continues beyond the outreach. We examined how parents supported their child interacting with the science-related exhibits in the Outreach program, investigated parents' perceptions of their role in promoting such interactions, and the impact of the outreach on their own attitudes about science and confidence in engaging with their children in science. Specifically, we asked:

1. What kinds of supportive behaviors do parents demonstrate in their interactions with children during the Outreach program?
2. What science-related activities do parents engage in with their children following participation in the Outreach program?
3. What are parents' perceptions of the impact of their participation in this science-based Outreach program on their awareness of the everyday nature of science, and on their interest, inspiration and confidence to engage with their children in science?
4. What reasons do parents give for any changes in their perceptions as a result of the Outreach?

## **Context of the Research**

The Early Childhood Outreach program was developed by a science center to visit community playgroups and engage young children in age-appropriate science learning experiences. The stated aims of the Outreach were (a) to introduce and engage young children in everyday science, (b) to promote scientific discovery through play, and (c) to provide ideas and resources for parents to encourage scientific discovery with their children both during and subsequent to the outreach program. A range of interactive exhibits and other activities (clustered into groups relating to sound, light, push-pull, and animals) were transported to the community venue at the invitation of the playgroup leader. The two presenters arrived before the parents and set out the activities. The hour-long program began with the children (usually numbering between 8 and 15) gathered together while one presenter used a puppet to introduce the five human senses and encourage children and parents to explore the activities using all of their senses (about 10 minutes). During the next 40 minutes, children, parents and presenters interacted with the science activities, while the presenters talked with children, asked questions and generally modelled inquiry behavior. In the final 10 minutes, children were again gathered together and asked about their favorite activity. To close the program, they read a book with a presenter or sang a song together.

The presenters endeavored to encourage the involvement of parents with their children during the Outreach program. On arrival, parents were given a concise, A5-size, Information Handout explaining the importance of play and the use of questioning to extend children's thinking. Parents were asked to read this and support their child during the program. One presenter explained at the start that the



program emphasizes learning through play and that the parents' role is to assist their child(ren)'s engagement, particularly through questioning. This science center routinely gathered feedback on its outreach performance, so at the end of each program, presenters ask parents to complete a short feedback questionnaire about their perceptions of the Outreach program. The questionnaire was completed voluntarily and anonymously, but because it occurred as parents are gathering their children and belongings to move to the playgroup refreshment break, not all parents chose to complete it.

## Research Design

Three factors were important in designing the research. First, to set the research in context, we needed to have some understanding of parents' typical response to the Outreach. Second, because we were investigating the impact of parents' participation in the Outreach, the research needed to be longitudinal but our resources allowed us to follow only a small number of parents for post-Outreach data collection. Third, to be credible, the research should not interfere with the usual playgroup routine with the inclusion of the Outreach that took place at the invitation of the playgroup members.

We met these requirements by designing the research in two stages. Stage One was designed to obtain an overview of parents' perceptions about the Outreach program and their children's responses to it. To obtain this "big picture" information about parents' response to the program, we employed a short, minimally intrusive, anonymous exit questionnaire that could be administered by the presenters at the end of the program in place of their own routine feedback questionnaire, thus not changing the usual sequence of the Outreach. This survey data collection was ongoing throughout the entire research program over about two years and provided a substantial baseline of parents' perceptions and a starting point to investigate impact.

Stage Two was designed to gather detailed data from a small sample of parents and their children to understand parents' perceptions about their child's learning and their actions in the weeks following attendance at the outreach program. Parents' supportive behavior with their children was observed during the Outreach and recorded using video and field notes. To learn about parents' actions in the weeks following the Outreach, data was collected from them using face-to-face interviews. These occurred at subsequent playgroups. It was a difficult task, because playgroups are busy and noisy, and parents' attention would be on their child(ren), but we considered it the best way to obtain the data we sought.

Stage Two of the research design was essentially naturalistic because we wanted to investigate the Outreach and its outcomes in circumstances that were as natural as possible. The researchers were able to observe the playgroup activities as non-participant observers (although occasionally a child or parent asked questions or invited our participation), but we did not intervene in the nature or delivery of the Outreach program. This stage involved data collection from 15 parents and their children during three visits to each of the five playgroups that agreed to be involved in the research.

## Data Collection and Analysis

### *Stage One: "Big Picture" Data Collection by Exit Questionnaire*

At the beginning of the research, the researchers worked with Outreach staff to devise a questionnaire to be administered by the presenters at the end of each Outreach presentation to replace their own feedback questionnaire. Items were prepared to cover the stated aims of the Outreach (see above) and the research questions, that is parents' perceptions about interacting with their children during the science-related activities. Following scrutiny by the staff and researchers and field-testing with separate playgroup parents, a 12-item questionnaire was finalized. The 5-point Likert-response format was Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree.

The questionnaire had three clusters of items. Four items, labelled *Engagement in Program*, asked about parents' and children's engagement during the Outreach program. Five items, labelled *Parent-Child Interaction*, probed parents' perceptions of their interactions with their child. The last three items, labelled *Parent Benefit*, referred to parents' perceptions of the value of the program to themselves. The content of the items is shown in Table 1. Presenters administered the questionnaire at the end of each Outreach session over the two years of the research project. Data analysis was performed using IBM SPSS Statistics.

### *Stage Two: Data collection from parents in the research playgroups*

Following institutional ethics approval, playgroups were selected in consultation with the science center from those who made bookings for the Outreach according to the availability of the researchers. The playgroup leader was contacted and a request made to visit the playgroup to explain the research and invite parents' participation. A few approaches were refused (mainly for reasons of convenience) but five playgroups agreed to participate. We chose four playgroups across a range of socio-economic suburbs in a large metropolitan area, from established to newer suburbs, and one playgroup in a rural, farming area about 140 miles distant. The researchers attended each playgroup the week before the Outreach was scheduled to introduce themselves and explain the nature of the research and data collection to both parents and children. Written summaries of the planned research and use of its outcomes were given to parents together with permission slips that could be signed by parents with children aged approximately 3 to 4 years who were willing to be involved in the research. A total of 20 parents agreed to participate in the research. Data collection occurred over three subsequent visits to each playgroup. Due to irregular attendance at the playgroups, full data sets were obtained for 15 parents

### *Visit 1: Observation of the Outreach Delivery*

Two or three researchers attended the playgroup during the Outreach program and observed the entire session. During the time children were engaged with the activities, their interactions were video-recorded by two researchers using portable dig-

ital tablets. The third researcher, when present, made field notes about the entire playgroup session. Several short recordings were made for each parent-child dyad, taking care to video-record only those dyads for whom permission was given. This varied from three to five dyads for each playgroup; the maximum that could be managed by the researchers in the 40 minutes of activity time available. Because the first strand of our research focused on children's interactions with the Outreach exhibits, some recordings contained only the child.

**Analysis of Video-recordings.** The video-recordings for each child were viewed several times and a descriptive time-log compiled of the child's activity and any interactions with the parent, peers, or the presenter. Because of playgroup noise it was difficult to hear what was said, so it was not possible to analyze conversations. These logs were used extensively in our investigations of children's exhibit interactions in the first strand of our research, but because parents were visible in many of the video-clips, we were also able to use them to describe any parent-child interaction. As a token of good will, each parent was given a copy of a book entitled *Science Is Everywhere* (Howitt, 2010), an illustrated story book for young children.

### *Visit 2: First Parent Interview*

In the week following the Outreach visit (for two playgroups, the second week following), the researchers revisited the playgroup and interviewed each parent. Open-ended questions asked about their background relating to science, their understanding of play, their role during the Outreach in helping their children to learn science through play, and any science-related activity they had engaged in with their child as a result of the Outreach. Interviews were audio-recorded (with permission). To maintain a naturalistic approach and to minimize interruption to the child's and parent's activities, we interviewed parents when they were available. Usually this was a moment when their child(ren) was engaged in play, in a place that was quiet (if possible) but where the parents could keep an eye on their child. Depending on the patience and other needs of their child(ren), not all questions could be asked. Occasionally, a child stayed with the parent during interview and was included in the conversation by the parent. The time available for interview varied according to the child(ren)'s activity, generally between 10 and 20 minutes.

### *Visit 3: Second Parent Interview*

Seven weeks following the Outreach visit, the researchers returned to the playgroup and re-interviewed the parents at a time that minimized inconvenience to them. Parents were asked again about any follow-up science-related activities they had engaged in with their child. New open-ended questions inquired about parents' perceptions of the impact of their participation in the outreach program on their awareness of the everyday nature of science; their inspiration, and confidence to engage with their children in science; and reasons for any changes in their perceptions as a result of the Outreach. Interviews were audio-recorded and later transcribed. As playgroup attendance was inconsistent, only 15 of the original 20 parents were available for re-interview, and not all questions could be asked if parents were interrupted by the needs of a child.

All of the participating parents were mothers (there were no fathers in these playgroups). Seven had some background in science or health sciences, and three mothers were teachers, two of whom had a science background.

**Analysis of Interviews.** Interviews were transcribed verbatim and the transcripts analyzed using an inductive process following Cresswell (2008). For the first set of interviews, each transcript was first read in total to obtain an overall sense of the data. On a second reading, notes were made of the key ideas expressed by parents. All responses to the same question across the sample were read, then reread to highlight segments that illustrated the key ideas in parents' responses. These ideas were coded within each question and when appropriate collapsed into themes. This iterative process revealed that the ideas expressed in response to some questions overlapped with responses to others. Each complete transcript was read again to ensure that each theme present was coded wherever it appeared in the transcript. A spreadsheet was prepared for parents across questions and checked to ensure that any code for each theme expressed was represented only once for each parent.

This analytic procedure was repeated for the second round of interviews and again, overlaps were found between some questions. In tallying results, care was taken to ensure themes were coded just once for each parent interview. These data were added to the spreadsheet, enabling ready access to the coded responses for each parent over all interview questions.

## Results

The "big picture" findings from the exit questionnaire in Stage One of the research are reported first, followed by Stage Two findings from the parents observed and interviewed in five playgroups. As noted earlier, data about children's interactions with, and learning about, the exhibits are reported elsewhere (Howitt & Rennie, 2021; Rennie & Howitt, 2020).

### *Findings from Stage One: The Outreach Exit Questionnaire*

Over the two years of the research, baseline data about parents' perceptions of their participation in the Outreach visit were collected by the 12-item, Exit Questionnaire. A total of 465 questionnaires were collected from 1828 parents in 73 playgroups (including the 5 research playgroups), a 25.4% response rate. The responses were analyzed with items scored 1 (Strongly Disagree) through 5 (Strongly Agree). Table 1 reports the percentage frequency of response choices for each item. Although it is recognized that the item data are ordinal rather than interval, there is clear empirical evidence that data from Likert scales (clusters of items) can be treated as interval (Carifio & Perla, 2008) and parametric methods can be used for their analysis (Norman, 2010). Further, the sample is comparatively large and calculating such statistics assists in interpreting the results. A principal component analysis supported the a priori clustering of items into three subscales of the questionnaire. The mean, standard deviation and internal consistency, measured by Cronbach's Alpha, for each subscale is also reported in Table 1.

Table 1 Responses to the Post-program Questionnaire (n = 465)

Item Content	% Frequency of response					Subscales		
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	M	SD	Alpha
Engagement in the Program						4.39	0.44	.75
1 The program was engaging for my child	53.1	45.0	1.9	-	-			
2 The program was engaging for me	30.8	63.0	6.0	0.2	-			
3 I could see my child learning science through play	40.2	54.4	5.4	-	-			
4 My child and I easily understood the language used in the program	51.2	41.1	7.3	0.4	-			
Parent-Child Interaction						4.38	0.44	.86
5 My child and I explored most activities	52.3	43.2	3.4	1.1	-			
6 The program encouraged my child and me to explore together	49.5	46.0	4.3	0.2	-			
7 I understood my role in helping my child to learn	49.5	48.2	2.3	-	-			
8 I was comfortable asking my child questions about the activities	47.1	46.9	5.8	0.2	-			
9 I was comfortable showing my child how an activity worked	51.6	46.2	2.2	-	-			
Parent Benefit						4.06	0.62	.85
10 This Outreach program has increased my interest in science	22.8	49.2	26.5	1.3	0.2			
11 This program has inspired me to engage more with my child in science	30.3	55.3	13.8	0.6	-			
12 This program has made me more confident to engage my child in science	28.0	54.4	16.5	1.1	-			

Note. Means were calculated by scoring Strongly Agree = 5 to Strongly Disagree = 1.

The results in Table 1 reveal that parents were very positive about the outcomes of the visit, with means over 4 on every subscale. For items referring to the Child's Engagement in the Outreach, more than 50% of parents selected Strongly Agree for Item 1 (The program was engaging for my child) and Item 4 (My child and I easily understood the language used in the program). Still positive, but less so, were parents' views about their own engagement with the program (Item 2, 30.8 % responding Strongly Agree) and that they could see their child learning through play (Item 3, 40.2% responding Strongly Agree).

Parents' responses were uniformly positive about the next cluster of items relating to Parent-Child Interaction. The Strongly Agree responses varied from

47.1% for Item 8 (I was comfortable asking my child questions about the activities) to 52.3% for Item 5 (My child and I explored most activities). Clearly parents felt generally comfortable exploring activities with their child.

The last three items about Parent Benefit indicate that parents were moderately positive about their own interest in science, and their inspiration and confidence in helping their children. The mode response for these items was Agree, with the Strongly Agree responses varying between 22.8% for Item 10 (This Outreach program has increased my interest in science) and 30.3% for Item 11 (This program has inspired me to engage more with my child in science). The only parent to respond Strongly Disagree to any item gave this response to Item 10.

In summary, the findings indicate that parents responded positively to the Outreach experience. They found it engaging for their children and, to a lesser extent, for themselves, and they felt comfortable supporting their child's interactions. These findings suggest that parents believe the Outreach has potential to encourage their children in science-related play. The Stage Two findings speak to this potential.

## Findings from Stage Two: The Outreach Visit and Parent Interviews

The findings reported here are based on those 15 parents who participated in both interviews, when the researchers re-visited the playgroup one or two and seven weeks after the Outreach visit. They include one parent who could not be present for the second interview but replied to the questions by post.

### *Parents' Interaction with Their Child During the Outreach Visit*

A summary of the supportive behaviors demonstrated when parents interacted with their children during the Outreach is shown in Table 2. The summary is based on analysis of the logs prepared from the video-recordings of parent-child dyads and the observation field notes taken by the third researcher. Table 2 reports these behaviors listed according to relative frequency of occurrence. The data are not quantified because the video-records covered only a part of the Outreach visit. The most common behaviors were supporting children to physically master the exhibit and asking questions to guide their activity. In the following excerpts from a video log, a girl interacts with an exhibit comprising three pumps that blow objects in tubes, then explores an exhibit comprising a set of small canisters containing substances to sniff. Pictures representing the source of the smells are on a chart.

[Girl] tries to use a pump but is unable to master the physical function. Her mother tries to help, but girl appears to lose interest and walks away.

[Later] [Girl] has returned to the pumps and successfully operates them. She operates the glitter pump, then moves on to successfully try each type of pump twice. The air flow tubes of the pumps were positioned in the wrong order, and she corrected them. She didn't ask questions but seemed focused on the task and inquisitive of the results, which drove her to test all three pumps multiple times. Mother watched but was not involved.

Mother asks [girl] if she can match the smell from the canister with the picture [on the chart], and later she asks what the smells remind her of. [Girl] starts to verbalize what she's smelling without prompting from her mother. She smells most canisters three times each and expresses enjoyment at the outcome. (Outreach visit, PG4, P3 represents Playgroup 4, Parent 3)

Overall, the mother in this excerpt took little part in her daughter's activities and the child worked her way around the activities spending most time at those that interested her. The mother (who had no science background) made occasional comments or asked questions, but the only guidance offered was at the smells exhibit. As noticed by Dooley and Welch (2014), the girl refocused her activity by simply walking away.

Table 2 *Parents' Supportive Behaviors in Video-Recorded Interactions during the Outreach*

Nature of Supportive Behavior
Helped own child by holding, pointing, directing, showing what to do with exhibit
Asked questions that guided child to particular actions, or suggested they try new approaches
Gave explanations although children often were not listening
Controlled behavior such as sharing with others
Sometimes assisted other children by holding, pointing

*Note.* These data are for the 15 parents who responded to both interviews.

Table 2 shows that parental behavior generally matches that reported in the research reported earlier. Parents scaffolded their children's learning by questioning and helping with physical exploration of the exhibits. Children were more interested in their own exploration than parental explanations. It was observed that some mothers were more attentive and supportive of their child than were others, even when younger siblings were present. Often children did not respond to their parents' questions, a characteristic of young children reported by Hedrick et al. (2009). Mothers all knew each other and their children, and they treated the Outreach visit very socially, talking to each other and sometimes helping other children as well as their own.

### *Parents' Understanding of Their Role During the Outreach Visit*

At the first interview, mothers were asked if they understood their role of assisting their child to learn, the importance of helping their child through play, and the importance of asking questions. They were also asked if they felt comfortable in their "helping roles". Thirteen of the 15 mothers replied that they were comfortable, one was called away and could not respond, and one felt unsure of what her role was meant to be. The importance of play and the parents' role in participating with their child were covered on the Information Handout provided at the beginning of the session, but only 2 of the 8 parents asked had read it. One mother who had not read the leaflet was confused about her expected role, stating:

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There was no guidance at the time and I didn't know whether to encourage [her son] to stay at one activity or to move him on to the next. As the morning progressed and I saw what the other mothers were doing, I felt more comfortable and tried to be encouraging. (Int1, PG1, P2; represents Interview 1, Playgroup 1, Parent 2)

Most parents (11 of 15) said that they understood the importance of play, including all three who were teachers. One said, "It's the best way to learn and is a much more subtle way to learn than formal teaching. Play is just as valuable" (Int1, PG1, P3). Parents reported a range of ways they assisted their children during the Outreach visit and these are summarized in Table 3.

Table 3 *Parents' Self-Reported Ways of Supporting Their Child During the Outreach Visit*

Description of ways	No of parents (n=15)
Asking open-ended questions about the activities	13
Encouraged the child to be actively involved	6
Played with their child in a co-operative way	6
Parent endeavored to model inquiry behavior	3
Allowed child to choose activities as they wished	2
Tried to move child along through the activities	1

The content of Table 3 is generally consistent with mothers' behaviors observed during the Outreach visit, shown in Table 2. Table 3 shows that most parents reported that they encouraged their child's activity by asking questions and playing cooperatively. For example, a parent (who was a teacher) was asked if she understood the importance of asking questions and if she comfortable doing so.

Parent: Yes, because then it makes you understand if they actually know what they're doing and understand what's happening and if they're clicking with the activity or no. So otherwise, if you're not asking questions you're not, you don't know what's going through their mind. If they're using it for the sake of using it or are they actually understanding now if they do that; put something on the balancing scales it goes down and the other side goes up. They may do stuff but they may not register what it is and if you ask questions then they can tell you and if you know they're on the right line of thinking then, yeah. If not, you can direct them to the right line of thinking and yeah, help them understand. (Int1, PG4, P2)

Parents who were not teachers and had no science background also understood the place of questioning, active involvement and play during the Outreach.

At this low [science content] level I was [confident], yes. Once it starts getting a bit more complicated, probably not. Because I wasn't that good at science. The basics, I was happy with [daughter's] age to explain it all to her. I was comfortable with the idea [of the children learning through play], because I think at this age that's the best way for her to learn. And you have to learn through experience. And I was comfortable with the role [of questioning]. To see if she grasped it and got any sort of concept of the whole thing. Just to know that she's enjoying it or not. You always want to



know what your kid's thinking. (Int1, PG4, P1)

The activities were quite easy to work out. So it was easy to show them what to do ... how things work and that kind of thing. We learn all the time when we're playing at home. Play is how they learn, and that's what we're doing all day basically. [Questioning] is just something you do every day. It's when they're doing things, asking them what their understanding is of, and sort of why they think things, do certain things. (Int1, PG5, P1)

### *Activities Undertaken Following the Outreach Visit*

At each interview, parents were asked about any science-related activities they may have done as a consequence of their participation in the Outreach. Seven themes were identified from interview transcripts and their frequency of mention are reported in Table 4. The dominant themes were discussion about the Outreach activities and other science-related activities, including cooking, floating activities in the bath, and so on. The frequency of these activities did not decrease in the weeks after the Outreach, with more activities reported at the 7-week interview. Because parents were interviewed individually with open-ended questions, in circumstances where interruptions were common, only the topics they chose to talk about became the data. For example, a few parents commented on their child's interest but most parents did not. This does not mean that their child was not interested; it was simply a topic that was not mentioned. Importantly, no parent reported that their child was not interested.

Table 4 Parents' Reports of Science Activities Following the Outreach Visit

Description of themes	Frequency (n=15)	
	Interview 1	Interview 2
Discussion/asking questions about things directly related to the Outreach visit	6	11
Science activities not directly related to the Outreach activities or books	5	9
General comments about enjoyment of the Outreach visit	3	6
Parent comment on their child's general interest in science	3	4
Looking at/talking about <i>Science is Everywhere</i>	2	1
Parent's plans for future activities	2	1
Doing activities that build on or extrapolate from the Outreach activities	-	3

Quotes from parents relating to the three most frequent themes in Table 4 are presented below to describe science activities following the Outreach. In both interviews, parents often gave examples of what they had done with their child that was a direct consequence of the Outreach.

[Daughter] played with the binoculars during the Outreach visit. She told her Dad

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about this when he came home from work and he managed to find an old pair at home. [Daughter] played with her Dad's binoculars and carried them for several days after the visit. [Daughter] showed an interest in 'bigger' and 'smaller' things around the home during the past week. (Int1, PG1, P3)

[Son] talked a lot about the bugs – the bug center. So we went out and bought some extra bugs for our sandpit. We set them up like they were set up here [in a sandpit]. [He would] sieve and dig [for insects] and he liked to show his younger brother what he was doing as well. (Int1, PG5, P3)

He was on his scooter and he was talking about how it moves slower on grass than on the footpath ... the same as when cars would go down the track [the ramp in an Outreach exhibit]. He made the comparison with the cars and the little tracks. (Int2, PG2, P1)

In this last quotation, a boy has been able to connect an Outreach experience with another event, building his understanding of friction. The term "friction" was not used, but the groundwork for later understanding was laid.

In both interviews parents commented on science-related activities they had done that were not directly related to the Outreach activities. Often they invoked prior knowledge to link events, a technique used often in family conversations (McClain & Zimmerman, 2014; Szechter & Carey, 2009). An example is this snippet of interview when a parent talked to her son.

Parent: What did we notice when we came home [from a holiday]? What was growing in the pot?

Son: Some strawberries.

Parent: And what had the strawberries done while we were away?

Son: They ripe. (Int1, PG2, P2)

We were cooking and doing measurement stuff. I've been working on craft activities for rainbows, to do with science. (Int1, PG4, P1)

We have done a lot of float and sink activities at home in the bath, at the creek, at the local park and in the dam on the farm. We have continued to do a lot of cooking and increasing [son's] awareness of wet and dry ingredients and changing the substance by mixing, and subsequently the changes following cooking in the oven. (Int2, PG3, P3)

Many parents added comments about their children's enjoyment of the Outreach.

[Daughter] appeared to enjoy the Outreach more than a visit to [the science center] itself. [Daughter] tends to find the noise and stimulation of [the science center] too overwhelming. I felt the visit at playgroup was much better because it was on a smaller scale, with people she was comfortable with and held in a venue that enables [daughter] to go outside for a break when she needed it. (Int1, PG1, P3)

He talked about the big van and people from [the science center] coming and how he would like to see them again. (Int2, PG3, P3)

He talks a lot about “when [the science center] came to my playgroup”. He tells everybody. He’ll talk openly about “remember when [the science center] came to playgroup”. (Int2, PG5, P3)

### *Changes in Parents’ Understanding, Inspiration, and Confidence about Science*

During the second interview, parents were asked three questions about the effect of the Outreach on their attitudes about science; specifically, their understanding of the everyday nature of science, and their inspiration and confidence to engage in science with their children. The majority of parents agreed with each of the three questions and Table 5 reports parents’ responses, separated according to whether or not they had a background in science.

Table 5 *Parents’ Changes in Understanding, Inspiration, and Confidence about Science*

Has the program	No science back-ground			With science back-ground			<i>n</i>
	Yes	No	Oth-er <sup>a</sup>	Yes	No	Other <sup>a</sup>	
given you a <i>better understanding</i> of science?	7	-	1	2	3	2	15
<i>inspired</i> you to engage more with your child in science?	7	1	-	6	-	1	15
made you <i>more confident</i> to engage with your child in science?	6	1	1	4	1	1	14 <sup>b</sup>

<sup>a</sup> Other includes those who stated that the program acted as a reminder, raised their awareness, or they were not sure.

<sup>b</sup> One mother did not complete interview due to unhappy child.

The first question asked if parents thought they had a better understanding of the everyday nature of science as a consequence of the program. Seven of the 8 parents with no science background said “yes” and the other replied that she didn’t know and “wasn’t very good at science”. Of the 7 parents who had a background in science, 2 responded “yes” and 3 responded “no”, but the latter tended to say they were more motivated or they had obtained more ideas for activities. The “other” response was given by two parents. One parent replied: “I wouldn’t say I have a better understanding but I’m more aware of the science in my everyday path” (Int2, PG5, P3). The other parent (a science teacher) said that the program was more a “reminder” to talk about science, as she had not taught for a few years. She

answered the inspiration question in a similar way but then had to depart with a crying child without answering the final question about confidence. The one parent (with no science background) who answered “no” to the question about being inspired to engage more with her child about science responded by post and did not elaborate.

Parents were asked about their confidence in engaging with their child in science. One parent with a science background answered “no” to the question about increased confidence, explaining she did not lack confidence to do science. In contrast, the parent without a science background who responded “no” said she wasn't good in science and did not know what science activities to do with her son. Both parents whose responses were coded as “other” explained that they didn't think their confidence had increased; rather they had become more aware of their child's interest in science.

*Parents' Reasons for Changes in Understanding, Inspiration, and Confidence about Science*

When asked to explain any changes in their understanding, inspiration, and confidence parents offered a range of reasons. The interview transcripts revealed considerable overlap between the reasons given for these questions so the responses were analyzed together. Eleven themes were identified in parents' reasons for any changes in attitude, and these themes, together with their frequency of mention, are reported in Table 6. Almost all parents' responses covered more than one theme. Most often, parents spoke about how their eyes had been opened to learning opportunities relating to science in children's play, understanding the importance of asking questions, realizing how interested their child was in engaging with science, and responding to children's questions in ways to push their thinking. Parents also became more aware of the everyday nature of science; that science can be fun and engaging for their children, and that science can be made simple and/or age-appropriate.

Table 6 *Themes in Parents' Reasons for Changes in Understanding, Inspiration, and Confidence about Science*

Description of themes	Frequency
Eyes opened to learning opportunities	8
Importance of asking child questions	7
Realized child is interested/engaged in science	7
Awareness of everyday nature/importance of science	6
Now inclined to push for greater depth of understanding/explore concepts more	6
Science can be fun	4

Importance of age-appropriateness of activities	3
Visits to the science center	2
Science can be simple	2
Outreach visit a reminder about ways to help child learn	1

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*Note.* The responses of all but one of the 15 parents were coded into more than one theme.

A representative range of quotes from parents' responses are presented below and many overlap several themes. The next quotes are from parents who mentioned that their eyes had been opened to the importance of science and science learning opportunities following their participation in the Outreach.

Yes, I can see that it [science] is more important. They [the presenters] have opened my eyes to it. I like talking about it now – I want to be doing science activities at home because I know [son] would be interested and I would like to get him interested. I want him to enjoy learning and by having him doing these activities it would spark a little light in wanting to learn, to discover. (Int2, PG1, P1, no science background)

I think I make more of a conscious effort to keep an eye out for things and to explain. Before I probably wouldn't have really thought of anything when he said something like that. I guess I can see where there's learning opportunities. (Int2, PG2, P1, no science background)

These mothers have learned to be alert to “serendipitous science” (Vedder-Weiss, 2017), where an everyday happening provides an opportunity for family exploration of science.

Some parents mentioned that they had a better understanding of the importance of asking questions to help children think. They also seemed to have an appreciation of the importance of responding to their child's questions in ways that could extend their thinking.

I feel I am answering [son's] 'why' questions with a lot more detail, and in turn [son's] understanding is improved. I have become more confident as the program helped highlight the easy ways in which we can discuss science with our children – asking them WHY? (Int2, PG3, P3, no science background)

I think it makes me think about it more and, you know, not just gloss over it, but actually explore the concepts more and think about it; especially when he's asking questions. We got a family membership for [the science center] (Int2, PG2, P2, science background)

Other parents mentioned an increased awareness of the everyday nature of science and the importance of science as an outcome of being part of the Outreach.

I guess it makes you more aware that everything does revolve around science. (Int2, PG4, P3, no science background)

I suppose you don't really realize how much science is in your everyday, like say,

simple things, like looking through a magnifying glass, you don't think of that as science. I class it as a fun activity, or an everyday utensil. So I wouldn't say I have a better understanding but I'm more aware of the science in my everyday path. (Int2, PG5, P3, science background)

Several parents described that they now respond to children's questions in ways to encourage thinking (for both the children and the parent) as a consequence of participation in the Outreach.

Yes [I am more confident] I didn't realize how interested he was in science. I just thought he liked playing. So we have made a bit more of an effort to, you know, talk about stuff. And remind him of what happened on the day and that we will go visit [the science center]. (Int2, PG1, P2, science background)

Probably to look for answers more than just say, "Ask daddy". I'm feeling like when he asks me a question, I'll look up the answer or something. I guess it's because I know he has noticed it and I can see where he's actually learning. (Int2, PG2, P1, no science background)

Overall, the results from the interviews were very positive. Seven weeks after the incursion the majority of parents believed they had a better understanding of the everyday nature of science and were more inspired and confident to engage their children in science as a consequence of participating in the Outreach program.

## Discussion

The purpose of this research was to explore the impact of parents' participation in a science-based outreach program on their subsequent behavior in promoting their child's science learning through play. Specifically, we explored parents' perceptions of the impact of their participation in the Outreach on their awareness of the everyday nature of science, and on their inspiration and confidence to engage with their children in science. We also explored the reasons parents gave for any changes in these perceptions.

In Stage One, we gained an overview of parents' responses to the Outreach program from a questionnaire routinely administered at the conclusion of the Outreach visit. The findings revealed that the 465 responding parents had very positive perceptions of their children's engagement in the Outreach program. They reported being aware of the place of play in learning and most were aware of their own active role in the program in terms of assisting their child. They were less positive about the benefit of the program to themselves, but even so, more than 70% of parents agreed or strongly agreed that the program had increased their interest in science, and more than 80% agreed or strongly agreed that the program had inspired them and increased their confidence to engage with their child in science-related activities.

To build on this baseline data and provide more detailed answers to our research questions, in Stage Two we analyzed video-recordings of parent-child dyads during the Outreach visit to five playgroups, and interviewed 15 parents one or two, and seven weeks after the Outreach visit to their playgroup. In answer to the first research question, we found that parents demonstrated a range of supportive

behaviors during the Outreach, including assisting children master the activities, answering or asking questions to guide exploration, and offering explanations. It was noticeable that these potentially scaffolding behaviors, reported in other research, were used more by some mothers than others. This suggested that there was scope for increasing parents' understanding of ways to support their child's learning.

The second research question asked about parents' follow-up science-related activities. During interviews parents observed that their children found the Outreach enjoyable and that they often talked about it, even after seven weeks. Parents' comments provided evidence of the transfer of activities and ideas from the Outreach program to the home environment, such as floating and sinking in the bath. At the same time, parents described a range of science activities done at home that did not relate directly to the program, including cooking and gardening.

The third and fourth research questions asked about parents' perceptions of the effect of their participation in the Outreach. The responses emphasized parents' desire to do the best for their child. They wanted to support their children but did not always know how to scaffold learning, particularly if they felt inadequate in science; a finding also reported by Zimmerman et al. (2010). Enjoying science-related outreach activities with their children provided opportunities for parents to recognize or reinforce that children learn through play. Seeing the Outreach presenters model inquiry behavior and observing their children's interest and response to open-ended questioning, encouraged parents to pay more attention to their child's questions at home. Further, the Outreach activities demonstrated that science is "everyday", and that it can be accessible at an early age. Following the Outreach visit, most parents, even those with a science background, felt more confident and inspired to engage their child in science. Furthermore, and consistent with research by Callanan et al. (2017), Eberbach and Crowley (2017), and Franse et al. (2020), that demonstrated that parents can be coached to change their supportive behavior, it seems that participation in the Outreach had similar effects.

## Reflections on the Research Design

Confidence in the research findings of studies such as this depends on the credibility of the research design, and the dependability and generalizability of the findings. We designed the Outreach exit questionnaire in Stage One to look for patterns in these responses and provide a "big picture" of parents' response to the program. It was devised and field-tested to reflect our research questions in consultation with the science center staff, and therefore had face validity. Although it drew from a substantial sample of about a quarter of the parents attending the Outreach program over two years, this sample was voluntary and the possibility of bias cannot be dismissed. Nevertheless, the findings were consistent with our observations in five playgroups and also consistent with what parents reported to us in later interviews.

The interview questions were derived from our research questions and designed to provide a more detailed picture over time. This fine-grained, contextual data collection assisted understanding of the patterns we found from the questionnaire. Data were analyzed systematically by the researchers independently and produced consistent findings over interviews. It is possible that participation in

the first interview may have influenced responses in the second, but we found no evidence of that. However, qualitative research of this kind in the playgroup context does not enable the "thick description" recommended for naturalistic inquiry by methodologists such as Lincoln and Guba (1985). Because of the difficulty in doing lengthy interviews with parents in playgroups, we relied on retrospective reporting from parents and we could only analyze what parents chose to say. We could perhaps, with caution, generalize the findings from the questionnaire to the other parent participants in this Outreach visit, but the findings from the interviews, although credible, should not be generalized to parents in other playgroups who experience an Outreach visit.

Circumstances meant that our research was limited to mothers, simply because no fathers were present in the research playgroups, and our findings may not be generalizable to the behavior of fathers in playgroups. The playgroup parents we interviewed had English as their first language and were generally well-educated. Our findings are unlikely to be representative of families that do not attend playgroups and have different socio-economic and cultural backgrounds.

## Implications for the Outreach Provider

During the research, we had frequent interaction with the science center staff; we explained the objectives of the research, its progress, and we gave feedback workshops to staff. In making recommendations for the Outreach program's improvement, we stressed the importance of the presenters maximizing parents' involvement in the Outreach activities. We suggested that before the program, presenters ensured that parents were made aware of, and if possible read, the Information Handout that emphasized the importance of play and questioning in learning. When the program started, we recommended that presenters reiterate verbally the importance of parents interacting with children in the program activities, because the activities provided opportunities for learning for both. We suggested that presenters reinforce this connection in both the introduction and conclusion to the Outreach program. The science center had a Parent Activity Resource Book available that could provide valuable follow-up support for parents looking for science-related activities at home, so we suggested that these activities be reviewed to make connections between the activities and the home more visible.

The science center staff responded positively to our suggestions. Through program scripting and presenter training, they "tweaked" their next staff training program to emphasize the reinforcing of communication with parents about the goals of the Outreach session and the large role they play in it. As well, center staff were preparing a dedicated Early Childhood take-home book of activities for wider use with other programs, and developing additional program exhibits to emphasize the connection to familiar objects at home.

## Conclusion

In this paper, we reported findings suggesting that participation in a science-related outreach aimed at very young children and their parents had positive impacts on parents' ability to scaffold their children's learning. Parents perceived positive



benefits of the Outreach program to themselves in terms of their interest in science, and their inspiration and confidence to engage their child in science. Importantly, they reported that the experience had opened their eyes not only to the pervasiveness of science in their everyday world and the opportunities to take part in science-related activities, but they also recognized the interest and excitement shown by their children in being involved in such activities, and asking questions about things they were interested in. As a consequence of their participation, the majority of parents believed they had a better understanding of the role of questions to help children think and were able to respond to children's questions in ways to push for deeper understanding. We believe that participation in science-related outreach activities, such as those reported here, has the potential to encourage parents to assist their child's science learning through play.

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## References

- Ash, D. (2003). Dialogic inquiry in the life science conversations of family groups in a museum. *Journal of Research in Science Teaching*, 40(2), 138-162. <https://doi.org/10.1002/tea.10069>
- Ash, D., Crain, R., Brandt, C., Loomis, M., Wheaton, M., & Bennett, C. (2007). Talk, tools, and tensions: Observing biological talk over time. *International Journal of Science Education*, 29(12), 1581-1602. <https://doi.org/10.1080/09500690701494118>
- Briseno-Garzon, A., Anderson, D., & Anderson, A. (2007). Adult learning experiences from an aquarium visit: The role of social interactions in family groups. *Curator*, 50(3), 299-318. <https://doi.org/10.1111/j.2151-6952.2007.tb00274.x>
- Callanan, M. A., Castaneda, C. L., Luce, M. R., & Martin, J. L. (2017). Family science talk in museums: Predicting children's engagement from variations in talk and activity. *Child Development*, 88(5), 1492-1504. <https://doi.org/10.1111/cdev.12886>
- Carifio, J. & Perla, R. (2008). Resolving the 50-year debate around using and misusing Likert scales. *Medical Education*, 42(12), 1150-1152. <https://doi.org/10.1111/j.1365-2923.2008.03172.x>
- Cresswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Pearson Education International.
- Crowley, K., Callanan, M. A., Jipson, J. L., Galco, J., Topping, K., & Shrager, J. (2001). Shared scientific thinking in everyday parent-child activity. *Science Education*, 85(6), 712-732. <https://doi.org/10.1002/sce.1035/>
- Diamond, J. (1986). The behavior of family groups in science museums. *Curator*, 29(2), 139-154. <https://doi.org/10.1111/j.2151-6952.1986.tb01434.x>
- Dierking, L. D., & Falk, J. H. (1994). Family behavior and learning in informal science settings: A review of research. *Science Education*, 78(1), 57-72. <https://doi.org/10.1002/sce.3730780104>
- Dockett, S., & Fleer, M. (2002). *Play and pedagogy in early childhood. Bending the rules*. Thomson.
- Dooley, C. M. & Welch, M. M. (2014). Nature of interactions among young children and adult caregivers in a children's museum. *Early Childhood Education Journal*, 42(2), 125-132. <https://doi.org/10.1007/s10643-013-0601-x>
- Eberbach, C., & Crowley, K. (2017). From seeing to observing: How parents and children learn to see science in a botanical garden. *Journal of the Learning Sciences*, 26(4), 608-642. <https://doi.org/10.1080/10508406.2017.1308867>
- Fender, J. G., & Crowley, K. (2007). How parent explanation changes what children learn from everyday sci-

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- entific thinking. *Journal of Applied Developmental Psychology*, 28(3), 189-210. <https://doi.org/10.1016/j.appdev.2007.02.007>
- Fransé, R. K., Van Schijndel, T. J. P., & Raijmakers, M. E. J. (2020). Parental pre-knowledge enhances guidance during inquiry-based family learning in a museum context: An individual differences perspective. *Frontiers in Psychology*, 11, Article 1047. <https://doi.org/10.3389/fpsyg.2020.01047>
- Geerdts, M. S., Van de Walle, G. A., & LoBue, V. (2015). Parent-child conversations about animals in informal learning environment. *Visitor Studies*, 18(1), 39-63. <https://doi.org/10.1080/10645578.2015.1016366>
- Haden, C. A. (2010). Talking about science in museums. *Child Development Perspectives*, 4(1), 62-67. <https://doi.org/10.1111/j.1750-8606.2009.00119.x>
- Harlen, W. (2013). *Assessment & inquiry-based science education: Issues in policy and practice*. Global Network of Science Academies (IAP) Science Education Programme (SEP). <https://www.interacademies.org/publication/assessment-inquiry-based-science-education-issues-policy-and-practice>
- Hedrick, A. M., San Souci, P., Haden, C. A., & Ornstein, P. A. (2009). Mother-child joint conversational exchanges during events: Linkages to children's memory reports over time. *Journal of Cognition and Development*, 10(3), 143-161. <https://doi.org/10.1080/15248370903155791>
- Howitt, C. (2010). *Science is everywhere*. Author.
- Howitt, C., & Rennie, L. J. (2021). Using individualized photobooks to enhance 3- and 4-year-old children's science identity through a science outreach program. *Frontiers in Education*, 6, Article 662471. <https://doi.org/10.3389/educ.2021.662471>
- Idema, J., & Patrick, P. G. (2019). Experiential learning theory: Identifying the impact of Ocean Science Festival on family members and defining characteristics of successful activities. *International Journal of Science Education, Part B: Communication and Public Engagement*, 9(3), 214-232. <https://doi.org/10.1080/21548455.2019.161423>
- Knutson K., & Crowley K. (2010). Connecting with art: How families talk about art in a museum setting. In M. Stein, & L. Kucan (Eds.), *Instructional explanations in the disciplines* (pp. 189-206). Springer. [https://doi.org/10.1007/978-1-4419-0594-9\\_12](https://doi.org/10.1007/978-1-4419-0594-9_12)
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.
- Marcus, M., Haden, C. A., & Uttal, D. H. (2018). Promoting children's learning and transfer across informal science, technology, engineering, and mathematics learning experiences. *Journal of Experimental Child Psychology*, 175, 80-95. <https://doi.org/10.1016/j.jecp.2018.06.003>
- McClain, L. R., & Zimmerman, H. T. (2014). Prior experiences shaping family science conversations at a nature center. *Science Education*, 98(6), 1009-1032. <https://doi.org/10.1002/sc.21134>
- McLean, K., Edwards, S., & Mantilla, A. (2020). A review of community playgroup participation. *Australian Journal of Early Childhood*, 45(2), 155-169. <https://doi.org/10.1177/1836939120918484>
- McManus, P. M. (1994). Families in museums. In R. Miles & L. Zavala (Eds.), *Towards the museum of the future: New European perspectives* (pp. 81-97). Routledge.
- National Science Teachers Association (NSTA). (2014). *NSTA Position Statement: Early Childhood Science Education*. <https://www.nsta.org/nstas-official-positions/early-childhood-science-education>
- National Science Teachers Association (NSTA). (2009). *NSTA Position Statement: Parent Involvement in Science Learning*. <https://www.nsta.org/nstas-official-positions/parent-involvement-science-learning>
- Oxarart, A. L., Monroe, C. & Plate, R. R. (2013). From play areas to natural areas: The role of zoos in getting families outdoors. *Visitor Studies*, 16(1), 82-94. <https://doi.org/10.1080/10645578.2013.768074>
- Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Science Education*, 15(5), 625-632. <https://doi.org/10.1007/ss100459-010-9222-y>
- Piaget, J. (1929). *The child's conception of the world*. Harcourt Brace.
- Rennie, L. J. (2014). Learning science outside of school. In N. G. Lederman & S. K. Abell (Eds.), *Handbook of research on science education* (Vol. 2, pp. 120-144). Taylor & Francis.
- Rennie, L. & Howitt, C. (2020). The Children's Engagement Behaviour Framework: Describing young children's interaction with science exhibits and its relationship to learning. *International Journal of Science Education: Part B*, 10(4), 355-375. <https://doi.org/10.1080/21548455.2020.1851425>
- Riedinger, K. (2012). Family connections: Family conversations in informal learning environments. *Childhood Education*, 88(2), 125-127. <https://doi.org/10.1080/00094056.2012.662136>
- Schauble, L., Lehrer, R., Bardett, K., Petrosina, A., Allen, A., Clinton, K., . . . Street, J. (2002). Supporting science learning in museums. In G. Leinhardt, K. Crowley & K. Knutson (Eds.), *Learning conversations in museums* (pp. 425-452). Lawrence Erlbaum.
- Sincovich, A., Harman-Smith, Y., & Brinkman, S. (2019). *The reach of playgroups and their benefit for children across Australia: A comparison of 2012, 2015, and 2018 AEDC data*. Telethon Kids Institute, South Australia.

- Song, L., Golinkoff, R. M., Stuehling, A., Resnick, I., Mahajan, N., Hirsh-Pasek, K., & Thompson, N. (2017). Parents' and experts' awareness of learning opportunities in children's museum exhibits. *Journal of Applied Developmental Psychology, 49*, 39-45. <https://dx.doi.org/10.1016/j.appdev.2017.01.006>
- Szechter, L. E., & Carey, E. J. (2009). Gravitating toward science: Parent-child interactions at a gravitational-wave observatory. *Science Education, 93*(5), 846-858. <https://doi.org/10.1002/sce.20333>
- United Nations Committee on the Rights of the Child. (2006). *General Comment no. 7 (2005): Implementing Child Rights in Early Childhood*. United Nations. [www.refworld.org/docid/460bc5a62.html](http://www.refworld.org/docid/460bc5a62.html) Accessed September 7 2020
- Uzick, R., & Patrick, P. G. (2018). Family discourse on an arboretum nature trail: Explorers, protectors, rememberers, and sticky features. *International Journal of Science Education, Part B: Communication and Public Engagement, 8*(1), 76-93. <https://doi.org/10.1080/21548455.2017.1393119>
- Van Schijndel, T. J. P., Franse, R. K., & Raijmakers, M. E. J. (2010). The Exploratory Behaviour Scale: Assessing young visitors' hands-on behaviour in science museums. *Science Education, 94*(5), 794-809. <https://doi-org/10.1002/sce.20394>
- Vedder-Weiss, D. (2017). Serendipitous science engagement: A family self-ethnography. *Journal of Research in Science Teaching, 54*(3) 350-378. <https://doi.org/10.1002/tea.21369>
- Vygotsky, L. S. (1978). *Mind and society: The development of higher mental processes*. (Edited by M. Cole, V. John-Steiner, S. Scribner & E. Souberman). Harvard University Press.
- Zimmerman, H. T., Reeve, S. & Bell, P. (2010). Family sense-making practices in science center conversations. *Science Education, 94*(5), 478-505. <https://doi.org/10.1002/sce.20374>

