‘We practise every day’: Parents’ attitudes towards early science learning and education among a sample of urban families in Ireland

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Abstract

Educational policies increasingly emphasise early childhood science engagement. As key influencers in children's early learning, parents (n=85) attending a science workshop in three urban schools in Ireland were surveyed regarding their attitudes towards science. Seventy per cent of parents believed that science education should begin in the pre-school years, before the age of four. Despite high levels of education, at least half of the parents expressed some lack of confidence in talking about, and in doing science with, their young children. Parents who reported less confidence in doing science activities with their children also reported reduced frequency of activities for five out of the seven science learning opportunities listed. Mothers, compared to fathers, reported less confidence in doing science activities with their children. Findings indicate that parents' confidence in science may impact early science experiences and highlight parents as a key support for increasing early science engagement.

Keywords

Early Science Learning; Parent Attitudes; Early Childhood Education

Educational policies increasingly highlight the importance of science engagement in early childhood to establish solid foundations for subsequent engagement with science in schools and STEM (science, technology, engineering and mathematics)-related careers (Department of Education and Skills 2017, 6). This new focus on STEM-related skills is due to a move towards technological economies, which require a workforce with expertise in STEM disciplines to drive economic success (Newcombe 2017). Science enables citizens to measure, analyse, design and advance the physical environment: skills that are more crucial than ever in overcoming the series of challenges we face today, including climate change, poverty, and sanitation (DES 2017; Murphy, Smith and Broderick 2019).

Children begin school with a strong interest in science (Brown 1997; Chouinard 2007). There is ample evidence that young children have the capacity for science inquiry (Zimmerman 2007) but that they require appropriate experience to contextualise that scientific knowledge (Samarapungavan, Patrick and Mantzicopoulos 2011; Nayfield, Brenneman and Gelman 2011; Sikder & Fleer, 2018). For example, young children enjoy reading science books as much as other types of books (Mohr 2006; Price, Bradley and Smith 2012) and enjoy learning about science in preschool once they are familiar with the items and activities that are available to them (Nayfield, Brenneman and Gelman 2011). In addition to quality early opportunities for engaging in science activities (Patrick and Mantzicopoulos 2015), young children require frequent, positive interactions for increased confidence and interest in learning more generally (Lerkkannen et al. 2012; Helmke and van Aken 1995) and these may be a more important driver of educational achievement than self-concept of ability (Helmke and van Aken 1995).

This is in keeping with Vygotsky's work on the development of scientific concepts: Vygotsky (1994) posited that scientific concepts are non-spontaneous concepts, meaning that they can only develop through purposeful interaction or instruction with another. In this way

scientific concepts develop as part of the child's wider conceptual development and can only be learned when the 'ideal form' (i.e. a model of the final form of the scientific concept which the child will eventually learn) is present in the social context (see Sikder & Fleer, 2018, p.p. 869-872 for an in-depth discussion of Vygotsky's writing on the development of scientific concepts in childhood). In a Vygotskian framework of early science learning, the role of early childhood educators and caregivers is therefore critical in supporting the development of scientific concepts through purposeful interactions and playful instruction (Sikder & Fleer, 2018).

Although young children start school with a great interest in science (Patrick and Mantzicopoulos 2015), differences in science attainment emerge early and are evident by the third grade (Morgan et al. 2016). The impact of early science achievement on later science achievement mirrors established findings on the strong link between children's early academic achievement and later educational attainment (Chatterji 2006; Duncan et al. 2007). Using longitudinal cohort data, Morgan et al., (2016) found gaps in science achievement by the third grade which were most strongly predicted by general knowledge at entry to Kindergarten. Moreover, such differences in science achievement persisted through eighth grade, and were explained not only by prior science knowledge but also by a range of malleable factors including children's numeracy and literacy skills (Morgan et al. 2016). Gender disparities in science engagement and attainment also emerge early and persist throughout formal schooling (Baram-Tsabari and Yarden 2005; Matese and Tai 2011; Keeves and Kotte 1992). Together, these findings highlight the need for early intervention in science education to tackle stark and persistent gaps in later science achievement for some groups of children, especially those from marginalised communities (Morgan et al. 2016) and for girls (Rhodes, Leslie, Yee and Saunders 2019) who are frequently under-represented in science disciplines such as physics and computer science (Meyer, Cimpian and Leslie 2015).

Targeting science in early childhood means ensuring support for, and consideration of, parents as key stakeholders in children's early learning (Dixon 1992). Young children's earliest informal experiences of science occur in the context of parent-child interactions (Crowley, Callanan, Tenenbaum, and Allen 2001). A growing field of research on children's early science learning has documented the varied informal science learning opportunities that parents provide through book reading, going to museums, and talking about science (Crowley, Callanan, Jipson, et al. 2001; Crowley, Callanan, Tenenbaum, and Allen 2001). Parents' attitudes towards, and beliefs about, early science learning and education are also likely to have an impact on young children's science engagement. For example, young children learn whether an academic subject is important from observing the frequency with which educators provide opportunities for learning in that topic (Turner 1995). Given the considerable control that parents exert over children's activities and interests (Bradley and Caldwell 1995; Chak 2010), it is reasonable to expect that young children also learn whether science is important by the extent to which parents talk about and provide opportunities to learn about or engage in science.

Despite the recognition of the importance of parents in science engagement, few studies have examined parents' attitudes to early science education or the activities they undertake with young children. Saçkes, Trundle and Shaheen (2019) profiled parents' preferences for various academic subjects, finding that science was ranked low in terms of curriculum importance, with few parents ranking science in the top three curricular choices. Of the 5.6% of the overall sample (84 of the total of 1490 parents) who ranked science as one of their top three curricular choices, 71% of these were classed as academically-oriented parents. Other studies have reported that parents generally tend to prioritize the learning of academic concepts and skills more than early childhood teachers (Dockett and Perry 2004; Fung and Lam 2011) and that parents have higher academic expectations for girls and perceive learning

of academic skills as more important for older pre-schoolers (Fung and Cheng 2012; Saçkes 2014). Parents may also afford daughters and sons different science learning opportunities throughout childhood (Jones, Howe and Rua 2000; Alexander, Johnson and Kelley 2012) as well as qualitatively different experiences with science when placed in similar contexts (Crowley, Callanan, Tenenbaum and Allen 2001). For example, when touring a museum exhibit, parents were more likely to provide explanations to their sons, whereas they were more likely to label the science content for their daughters. Such differences in explanatory talk were present despite spending similar amounts of time discussing exhibits with girls and boys (Crowley, et al. 2001).

The growing research literature on early science engagement and learning therefore points to the potentially critical role of parents in impacting young children's motivation and attitudes to science. Yet few studies have sought the views of parents regarding science in early childhood. In the current study, we surveyed parents who attended a mid-week morning workshop on early science learning and engagement on their attitudes towards science education for young children, namely whether science is an important topic for young children, the age at which science should be taught, and parents' confidence in discussing and doing science with their young children. The responses of this sample of highly motivated parents of young children in Ireland were also analysed with regard to (1) parent gender and (2) child gender in order to contribute to the growing literature on early gender differences in science engagement and opportunities for learning.

Materials and Methods

Participants

The survey respondents consisted of 85 self-selecting parents who attended a parental educational workshop on science in early childhood. That session was part of a larger

educational initiative run in the junior and infant classrooms (4-7 year olds) of three schools in a large urban area in Ireland and three feeder preschool classrooms. Parents who attended the workshops had children who were taking part in the initiative during school time. The parents completed the survey at the beginning of the workshop.

Parents were invited to attend the workshop via a leaflet describing the workshop aims that was sent home in the school bags of the 330 children participating in the initiative. Tea and coffee was provided and parents were told that all workshop participants would receive an educational science book to bring home (one per family). To facilitate attendance, the sessions were brief (30 minutes in total) and took place in the schools just after child drop-off in the morning. The overall response rate of the survey was 100% of parents attending the workshops and 25% of all participating children in the initiative.

Attendees were invited to complete the questionnaire by workshop leaders who were academics on the project team. The pen-and-paper survey was anonymously self-completed and took a maximum of five minutes to complete. Questions were set out in a fixed order (i.e. there was no rotation of questions).

Eighty-five parents (24 male, 60 female, and one person of gender unspecified) of young children (23 boys and 47 girls, and 15 children of gender unspecified, aged in months: $M = 73$, $SD = 7.9$, range = 57, 102) completed the survey. Most parents were between 30-39 (32%) and 40-49 (58%) years old, highly educated (36% had a graduate degree, 48% had a postgraduate qualification) and working outside of the home (34% part-time, 41% full-time). Parents were equally educated across gender ($p = 0.102$) and men were more likely to work full-time outside of the home ($p = 0.014$).

This survey study received ethical approval from the Research Ethics Committee at Dublin City University. All respondents gave written consent to participate in the survey.

Materials

The survey consisted of ten questions, five of which concerned demographics. Question six (when should children begin learning science), question nine (frequency of doing science activities), and questions seven and eight (confidence levels) were adapted from a published report (Silander et al. 2018). Question ten (general opinions on science) was adapted from the parental attitudes questionnaire as part of the TIMSS 2015 international report (Martin, Mullis, Foy, and Hooper 2016). The survey layout was not piloted due to time limitations. This may have resulted in the missing values detailed in the analysis section.

Analysis

All exploratory association testing was carried out using Fisher's exact test. Due to limited sample size some categorical levels were combined. For the confidence categories: 'not at all confident' and 'somewhat confident' were combined into 'less confident' while 'confident' and 'very confident' were combined into 'more confident'. For the frequency of activities category: 'daily' and 'weekly' were combined into 'frequently', while 'once or twice' and 'not this month' were combined into 'less often'. For the 'start to learn science' age groups, the ages were grouped into pre-school (0-4 years old) and at school (4 years old +).

Corrections for multiple comparisons (data inspections) were done using the false discovery rate (FDR) method (Benjamini and Hochberg 1995) within the following association analyses: 'doing' confidence and activities, 'talking' confidence and activities, gender and activities. The original (uncorrected) p-values of the Fisher's association tests are reported in the results section along with more conservative, corrected, p-values arising from the FDR method. All graphs and analyses were run with missing values excluded - no imputation was carried out. (There was 1 missing value for parent gender, 14 for child gender, and 5 for child age. All other categories had 0-5 missing values.) Analysis was

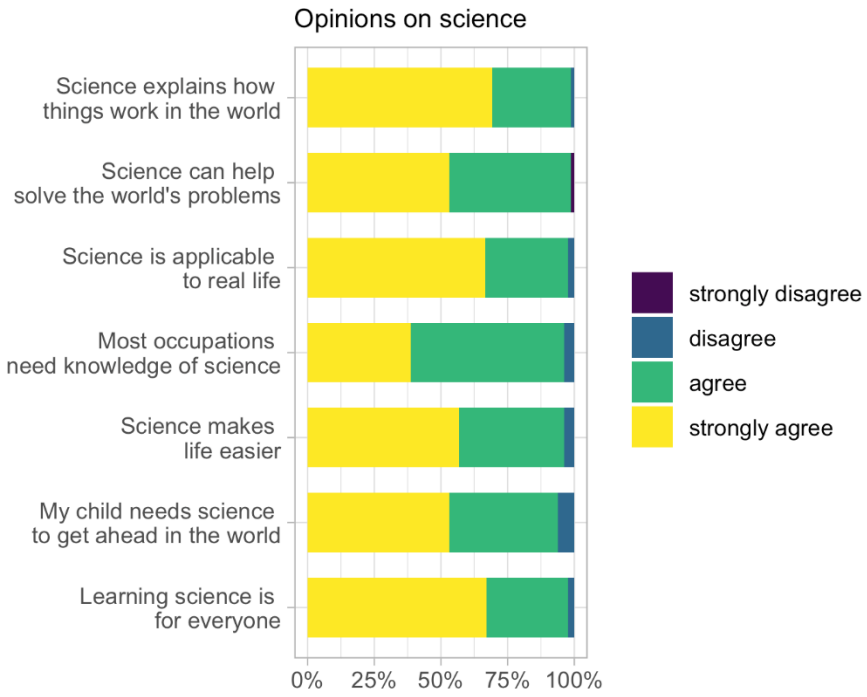
conducted using R version 3.6.1 (Team 2013), data preparation and visualization was completed using the *tidyverse* v1.2.1 package (Wickham 2017).

Results

Attitudes to Science

There was widespread agreement on the usefulness and importance of science across a range of factors including its role in the world of work, its ability to help solve world problems and everyday problems, and that learning about science is something everyone can engage in – see Figure 1. The level of agreement was so high that it would not have been meaningful to investigate for a change in opinion that was associated with the gender of the child or the parent.

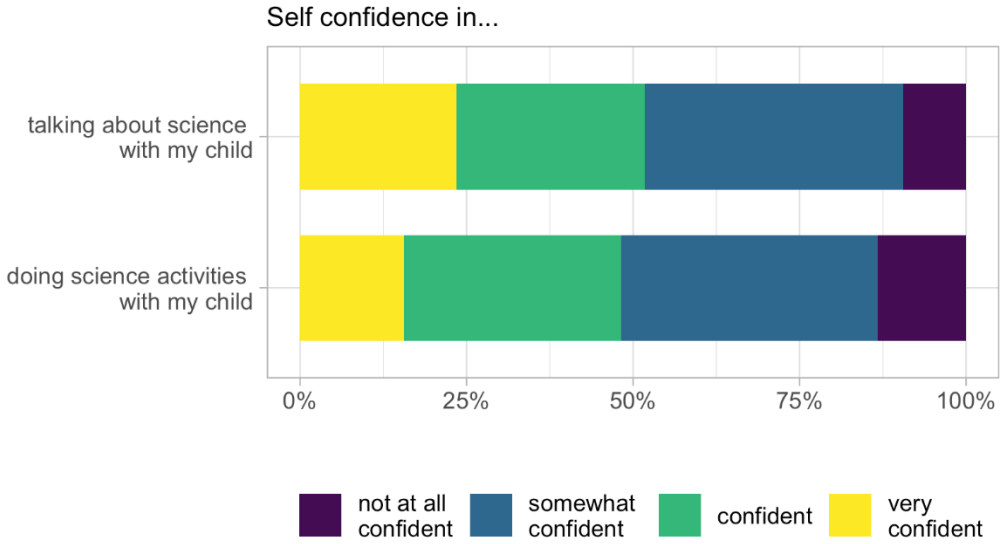
Figure 1 The extent to which parents agree to a range of statements on the value of science.



Confidence with science education

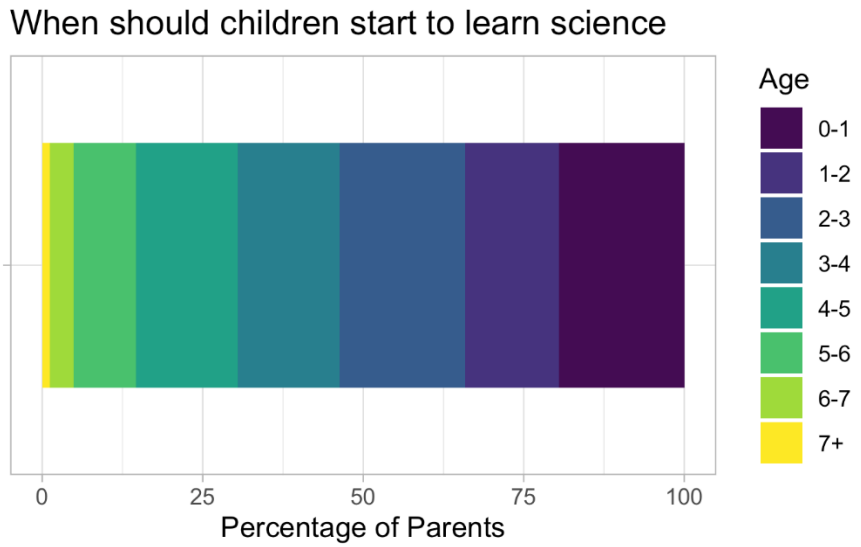
Just over half of parents (52%) felt confident in talking about science with their young children, with slightly less than half of respondents (48%) reporting confidence in doing science with children. This meant that just under half of parents reported some lack of confidence, with one in ten parents expressing no confidence in talking about and doing science with young children (see figure 2).

Figure 2 The extent to which parents report self-confidence in talking about and doing science with their child.



Just over half of parents (54%) thought that children should start to learn science before the age of 3. Most children in Ireland start preschool around age three as part of the universal two-year pre-school programme provided by the state (Department of Children and Youth Affairs 2019), thus the result suggests that the majority of parents in our sample thought that science learning should begin prior to the onset of formal early childhood educational experiences. When we include those parents who thought science learning should begin before age 4, the start of primary school, this percentage of parents increases to 70% (see figure 3).

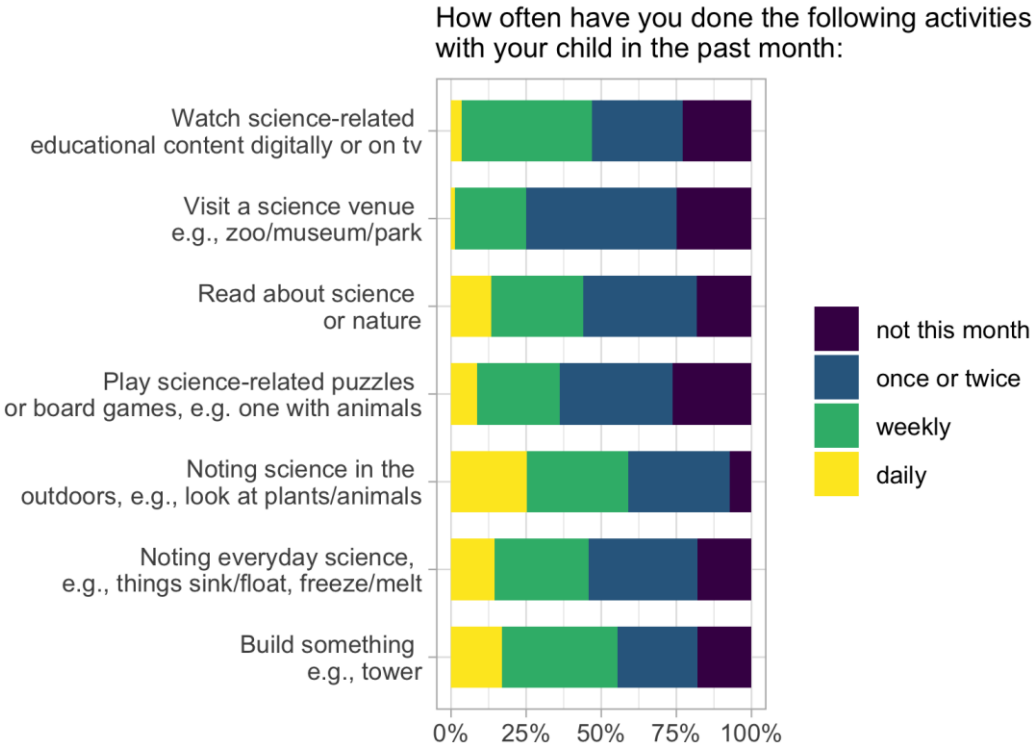
Figure 3 The age at which parents report children should start learning science.



Parent-child science-related activities

Parents reported taking part in many science-related activities with their children. Exploring nature outdoors was the most frequently observed activity, with 93% of parents reporting having participated in such exploration at least once or twice in the past month. When considering the activities that occurred at least daily or weekly, exploring nature outdoors (59%), building things (55%) and watching science (47%) were the most popular science-related activities. Playing science-related puzzles or games, and visiting a science-related venue were the least popular activities, with one in four parents reporting not engaging in these activities in the past month (see figure 4).

Figure 4 The reported frequency with which parents engage in specific science activities with their child.



Associations with parental confidence in talking about science

Level of confidence in talking about science with their children was associated with parent's gender at the uncorrected level; mothers expressed less confidence as compared to fathers (p_{uncorr} = 0.052, p_{corr} = 0.130, odds ratio = 0.341, 95% CI (0.104, 1.02)). There were no significant associations between child gender and parental confidence in talking about science, nor between the age at which parents' thought children should begin learning science and parental confidence in talking about science (all *p*'s > .05).

Associations between confidence in talking about science with their young child and the frequency of engaging in science activities (refactored levels) were examined. At the uncorrected level only, lower confidence in talking about science was associated with parental reports of reduced frequency in reading and watching science content with their children (p_{uncorr} = 0.027, p_{corr} = 0.13, odds ratio = 0.357, 95% CI (0.128, 0.953)) and (p_{uncorr} =

0.008, p_{corr} = 0.083, odds ratio = 0.290, 95% CI (0.104, 0.773), respectively), and in noting everyday science with them (p_{uncorr} = 0.048, p_{corr} = 0.130, odds ratio = 0.394, 95% CI (0.145, 1.03).

Associations with parental confidence in doing science-related activities

Level of confidence in participating in science activities was also associated with parental gender: compared to fathers, mothers expressed less confidence engaging in science activities with their young children (p_{corr} = 0.027, odds ratio = 0.23, 95% CI (0.064, 0.723)). Level of confidence in science activities was associated with child gender, with parents of girls expressing *more* confidence in doing science activities with their *daughters* whereas parents of boys expressed *less* confidence doing science activities with their *sons* (p_{corr} = 0.027, odds ratio = 4.72, 95% CI (1.37, 19.3)) but note the wide confidence interval.

No statistically significant association was found between parental confidence in doing science related activities and when children should start to learn science, (p_{corr} = 0.999, odds ratio = 1.02, 95% CI (0.344, 3.0)).

Reported (refactored) confidence in doing science activities with their children was associated with the (refactored) frequency with which they did activities. Those parents who reported less confidence did five out of seven activities less frequently with their children: reading (p_{corr} = 0.037, odds ratio = 0.348, 95% CI (0.125, 0.932)), playing (p_{corr} = 0.027, odds ratio = 0.286, 95% CI (0.093, 0.822)), noting science in the outdoors (p_{corr} = 0.037, odds ratio = 0.346, 95% CI (0.122, 0.937)), noting science in everyday activities (p_{corr} = 0.029, odds ratio = 0.306, 95% CI (0.110, 0.818)) and watching science content (p_{corr} = 0.027, odds ratio = 0.247, 95% CI (0.087, 0.669)). The alternative scenario, more confidence in doing activities being associated with doing activities more frequently, was also evident.

Gender differences and activity

The association between gender and the (refactored) frequency of doing science activities was inspected. Whether parents were male or female, there was no statistical difference in the reported frequency of the different activities they did with their children. Concerning the child's gender and the frequency of the activities parents carried out, no associations survived FDR correction.

Discussion

The 85 parents sampled in this study reported valuing science as both important and useful and were engaged in fostering an interest in science in their young children. Seventy per cent of parents believed that science education should begin in the pre-school years, before the age of four. Despite being highly educated at least half of the parents expressed some lack of confidence in talking about, and in engaging in science activities with, their young children. Parents who reported less confidence in science activities with their children also reported reduced frequency of activities for five out of the seven science learning opportunities listed (reading and watching science content, playing science related games and noting science in the outdoors and in everyday activities). Mothers, as compared to fathers, reported less confidence in doing science activities with their children. Parents of girls expressed more confidence in doing science activities with their daughters compared to parents of boys who expressed less confidence in doing activities with their sons.

Parents were not asked to rank the importance of science education on the curriculum compared to other subjects. However, the finding that the majority of parents believed that science education should begin before formal school and the high turnout for the workshop (25% of parents contacted made the time to attend an early morning optional parent workshop on science) would suggest that parents surveyed believe science to be an important

subject. This contrasts with previous research where few parents ranked science highly in early childhood education (Saçkes 2014; Saçkes et al. 2019). Our finding may reflect a growing trend and awareness of the importance of early science engagement for future academic attainment and, at the very least, indicates parental support for, and interest in, science for young children in Ireland. Indeed, in an evaluation questionnaire of the workshop parents were attending at the time of the survey, one parent wrote that they already had the science book that was given to parents attending the workshop, and that they '[We] practise every day' with it.

The survey results reflect two themes that have emerged in previous research on science education: the importance of parental confidence and potential early differences in science engagement and learning by child gender. Studies across the USA, UK and Scandinavia have reported that parents are enthusiastic about supporting science learning but that they experience anxiety and low confidence in their ability to help their young children (McClure et al. 2017; Solomon 2003; Vartiainen and Aksela 2019). Our results show that this lower confidence is present even among highly educated parents and that it results in a lower frequency of informal science-related activities for their young children.

Relating to gender, previous studies have revealed that parents are more likely to proactively support boys' interest in science (Bleeker and Jacobs 2004; Crowley, Callanan, Tenenbaum, et al. 2001; Simpkins et al. 2005) and that in order to evoke similar support girls must first express an interest to their parents (Alexander, Johnson and Kelley 2012). We found that mothers were less confident than fathers, and that parents of girls expressed more confidence in doing science activities with their daughters compared to parents of boys (with the caveat of wide confidence intervals). Lower expectations of girls in relation to science (Tenenbaum and Leaper 2003) may be at play in both of these results but our research design does not allow us to explore this hypothesis.

There are some limitations to this study. The sample is homogeneous and reports on the attitudes of a highly educated group of parents who are motivated to support young children in early science learning, as evidenced by choosing to attend an optional parent mid-week workshop on science. The sample is also small in the context of examining parents' perspectives nationally and internationally on early science learning. Therefore, further research is needed, such as a larger national and cross-cultural survey of parents of young children, in order to ascertain if the enthusiasm for early science learning reported in this study reflects a growing trend of awareness of and increased engagement in science among a diverse sample of parents. However, the homogeneity of the sample is also a strength in light of the survey's sample size, allowing us to report on the attitudes and confidence levels of a group of highly educated parents who shared high levels of motivation to support their children's early science learning.

In relation to enhancing parent confidence, there is good news. In order to support their children, parents do not need to be experts in science (Eshach and Fried 2005) nor do they themselves need to have an active personal interest or education in science (Pattison and Dierking 2019). Age-appropriate science encouragement can form part of everyday play and exploration (e.g., puzzles, block, the garden) (McClure et al. 2017). Indeed, play is an ideal context for purposeful early interactions around science as through play imagination and realistic problem solving merges (Vartiainen & Kumpulainen, 2020). Every-day and mundane home and family activities and routines are a source of knowledge and learning for children about the world and how they can interpret and understand it. These activities cover things such as noticing how people age, how there are different types of dogs, or that clouds have different colours. Thus, before they even enter school through questions and curiosity children can demonstrate an (age-appropriate) interest in and capacity to engage in scientific thinking (Andrews and Wang 2019; Crowley and Galco 2001). By being attentive and

receptive to their children's curiosity, parents support their child in developing skills such as evidence collection and critical thinking (Crowley, Callanan, Jipson et al. 2001). Positive affect (showing interest, fun, and approval) and attentive chatting (active engagement, promoting curiosity, asking questions, directing attention) are helpful tactics (Pattison and Dierking 2019). Science engagement can also be supported by visits to museums; however, we found that visiting a science-related venue was the least popular activity and this is potentially an important finding for policy makers highlighting that cost and time constraints may adversely impact families' opportunities to visit science centers. A dual policy approach may be warranted to increase visits to science-related venues, whereby government officials responsible for STEM education policy may wish to reduce or remove costs associated with visiting science centers such as zoos and museums while also increasing publicity around science events and festivals that may be relevant and open to young children and their families.

Overall, the findings reported here highlight high levels of parental interest in children's early science learning which reflects and contributes to ongoing policy efforts to increase public science engagement and understanding of science-related issues (National Science Foundation 2018; Science Foundation Ireland 2012). For policy makers and practitioners in early childhood education, the findings highlight the importance of engaging with parents as co-educators in early science learning, and of supporting access to opportunities for early science activities and learning for young children and their families.

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