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"The Parents Were Brilliant!" Engaging Parents in STEM Learning: Insights from Preservice Teachers' Field Experience

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Abstract: This study describes a field-based experience in parent engagement with preservice teachers, children, parents, and teachers in three Irish elementary schools, focused on a STEM education program, Science for Fun. Preservice teachers were enrolled in a parent engagement college course. The Science for Fun program provided space and time for preservice teachers, parents and children to explore basic scientific concepts in a supportive and inclusive context and involved the co-delivery of two hands-on science workshops between preservice teachers and parents in the school environment. The science activities were designed to enhance children's investigatory, problem solving, and critical thinking skills aligned with the curriculum for their age group. Participating schools had high levels of socioeconomic disadvantage and large numbers of families from the Irish Travelling community Therefore, the program aimed to inspire children and their parents to engage in science and to contribute, in some way, to the development of their science capital. Data were gathered from preservice teachers through structured reflective questionnaires after each Science for Fun workshop. They reported positive experiences in changing attitudes, overcoming fears, learning about challenges and developing communication skills for working with parents. They also reinforced their overall awareness and openness to their role as teachers of engaging parents in their future careers, as well as the central role that parents play in their children's learning and valuable insights that parents contribute. Participants reported learning how to organize and structure parent engagement in the classroom and that parents are a diverse group who have varying strengths and fears about partnership with schools.

Keywords: preservice teacher education; school, family and community partnerships; family and community engagement for student success; parent engagement; field experiences in teacher education; STEM education; equality; diversity; inclusion and interculturalism (EDII)

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1. Introduction

There has been increased recognition in Ireland and internationally that building effective school, family, and community partnerships should be a core competency for all teachers (Epstein 2018; NAFSCE 2022; Teaching Council 2020). Many decades of research have redefined a professional teacher as one who "knows how to work effectively with students, parents[1], other family members, community partners, and colleagues to promote

student learning, positive attitudes, attendance, and other important outcomes" (Epstein 2018, p. 5). Building cooperation with families has been identified by beginning teachers as one of their greatest challenges (de Bruïne et al. 2014; Epstein and Sanders 2006; Evans 2013; Willemse et al. 2016). Therefore, initial teacher education and professional development of teachers have an important role in developing teachers' competencies in this area (Epstein 2005). The focus of this research is to gain the perspectives of preservice teachers on a field-based experience of working with parents and their children on a STEM education program.

2. Teacher Education for School, Family and Community Partnerships

Teacher education programs worldwide have been slow to prepare teachers to develop school, family and community partnerships. Recent policy for reaccreditation of all teacher education programs in the Irish context has identified "professional relationships and working with parents" (Teaching Council 2020, p. 14) as a compulsory area of study and implementation of those programs is now underway so there is an immediate need to develop research-based practice (Ryan 2024; Ryan and Lannin 2021). In the US context, the National Association for Family, School, and Community Engagement (NAFSCE) is working towards nationally agreed core competencies for family-facing professionals in a variety of contexts (NAFSCE 2022) intended for use in guiding teacher preparation.

Current international research on family, school and community partnerships outlines promising developments in relation to what constitutes important topics for teacher preparation (Epstein 2018; Ryan and Lannin 2021) and that work is ongoing. The work of researchers at the National Network for Partnership Schools (NNPS), an effective university–school collaboration working with school districts and schools across the USA, has been leading the way since 1995 (Epstein 2019). Researchers at the Ohio Statewide Family Engagement Center have also created professional development, tools, processes and resources for families, school staff and organizations (https://ohiofamiliesengage.osu.edu/the-ohio-family-engagement-leadership-summit/ accessed on 27 November 2024). In Canada, Pushor (2015) has designed a "curriculum of parents", and there are also many developments in European countries (e.g., de Bruïne et al. 2014; Ryan and Lannin 2021; Willemse et al. 2016).

Research on effective schools has revealed that establishing goal-oriented, systematic partnerships among schools, families and communities is a key factor in school organisation for promoting student achievement (Bryk et al. 2015; Epstein 2018). Recent studies on family, school, and community partnerships have begun to explore how different types of parent involvement relate to specific student outcomes, highlighting the importance for educators to carefully choose the types of involvement they implement to meet defined school objectives and enhance student performance (Sheldon 2019). Extensive research across a range of subject areas and grade levels conducted with diverse populations also confirms that student learning in specific subjects is positively influenced by family engagement activities in those subjects (Epstein 2018; Sheldon 2019). Consequently, in addition to equipping future educators with the skills necessary to foster positive relationships and communicate effectively with parents and community members, they must also learn to design and implement goal-oriented engagement activities tailored specifically to enhance student learning in different subjects (Epstein 2018).

3. School, Family and Community Partnerships and STEM Education

The effects of school, family and community partnerships on pupils' science achievement have been less researched than literacy and mathematics but a few studies suggest that "parents' attitudes about science have a significant effect on student motivation and achievement" (Sheldon 2019, p. 52). Using a quasi-experimental design, Van Voorhis (2003,

2011) tested the effects of teachers' use of weekly TIPS[2] interactive science homework to promote parent–child science interactions and found increased science involvement for study families. TIPS students also had more positive attitudes to science homework and higher science grades (op cit.).

There is limited research on school, family and community partnerships in the delivery of STEM education outreach in Ireland (Lawton 2015; Ryan and Lannin 2021). This paper describes a field-based experience of STEM education with preservice elementary teachers, children, parents, and in-service teachers in three Irish schools. The Science for Fun program provided space and time for parents and children to explore basic scientific concepts in a supportive and inclusive environment. This approach involved the co-delivery of hands-on science workshops by preservice teachers and parents in the school environment (Ryan and Lannin 2021). Participating schools had high levels of socioeconomic disadvantage and a considerable proportion of families from the Irish Travelling community[3], a group that can experience the inaccessibility of STEM outreach and thus perceive the study of science and scientific careers as unattainable. With this EDII focus, Science for Fun aimed to inspire children and their parents to engage in science and to contribute, in some way, to the development of their science capital.

4. Science for All

There is a growing concern that the goal of science for all is not being met in the classroom and in everyday life. STEM education is important to enable all students to engage in discourse about and engage with STEM research throughout their lives (Trefil 2008). A STEM-literate society would allow people to practice STEM skills, making informed decisions about their everyday lives. STEM literacy is "the knowledge and understanding of scientific and mathematical concepts and processes required of personal decision making, participation in civic and cultural affairs and economic productivity" (National Research Council 2011, p. 5).

Research conducted by Science Foundation Ireland (2015) found that 94% of the Irish population consider science to be important, with 75% of people feeling that "science is useful in solving everyday problems in [their] lives" and, to a greater extent (91%), that "learning science changes [their] ideas about how the world works". However, only just over half (53%) of the population agreed with the statement that "with hard work, anyone can be a scientist". People with lower levels of education were less likely to see a "relationship between their real-world experiences and science" (Science Foundation Ireland 2015). A study in the USA found that "students from low-income families performed less well in science than their more affluent peers" (Von Secker 2004 cited in Sheldon 2019, p. 52). This indicates a need to ensure that people from all backgrounds and education levels have the opportunity to develop their STEM literacy and science capital.

5. Science Capital

Science capital is the measure of people's knowledge, attitudes, skills, and experiences with science. Capital refers to the economic, cultural, socially valuable, and exchangeable resources that individuals possess, which can affect their access to and engagement with education, which in turn relates to life opportunities. People with science capital engage with science as part of their normal, everyday life. It includes their science knowledge, opinions about science, and social networks of those who possess an understanding of science and engage with science daily (DeWitt et al. 2016).

The concept of science capital has been developed as a means to better understand why comparatively smaller proportions of students continue to study science once it is no longer compulsory and why these students tend to come from more socially privileged

communities (i.e., male, white, and middle-class) (Archer et al. 2015; DeWitt et al. 2016). Families with higher levels of science capital actively promote, develop, and sustain their children's interest and aspirations in science by incorporating and grounding science within everyday family life (Archer et al. 2012). Such intergenerational learning usually occurs informally, and involves the sharing of information, thoughts, feelings, and experiences between two generations (Istead and Shapiro 2014; Istead 2009). The influence that older generations have on younger people is widely accepted; however, this influence can also be bi-directional with children influencing the behavior of adults (Lawson et al. 2018). Therefore, it is important that children and families from all backgrounds and abilities should have opportunities to learn how science is practiced, to understand the role of science in society, and to make informed decisions about science-related issues in their daily lives (Liston 2015), thus having a positive impact on attitudes and interest in STEM.

STEM literacy and science capital are affected by a variety of factors and experiences i.e., exposure and engagement with science at school, at home, during informal learning experiences through educational outreach both in and out of school and everyday life experiences (Archer et al. 2015). Seebacher et al. (2021) found that students develop a highly positive science attitude if they experience supportive social environments, intrinsic motivation, science learning in school, as well as regular engagement in arts-based learning and self-directed science learning (Seebacher et al. 2021).

6. STEM Outreach and Ethnic Minorities

Participants in STEM outreach programs are generally from socially dominant groups, with people from socio-economically disadvantaged backgrounds and ethnic minorities less likely to participate (Dawson 2018). Many STEM education policies across the world state that social inclusion and equity are their key motivational drivers. However, across Europe there is less emphasis on other under-represented groups in STEM such as people from ethnic minorities and learners with special needs (Costello et al. 2020), while indigenous communities are absent from the European policy discourse (Marginson et al. 2013). The impact of support from parents in STEM education is actively being researched (Gülhan 2023) with positive effects being identified along with the importance of family participation in STEM activities.

Many reports have highlighted the cohorts in society that do not engage with STEM outreach. In Ireland, members of the Irish Traveller community are rarely seen to engage with STEM outreach and, as one of the most marginalized groups in Irish society, are underrepresented in education at every level. The Science for Fun program aimed to address this issue directly by developing accessible and inclusive science activities for parents and children from lower-socio economic backgrounds including those from the Irish Traveller community. This aligns with one of the main objectives of the Irish National Traveller and Roma Inclusion Strategy 2024–2028, which places an emphasis on education, ensuring equity of access, opportunity and outcomes, as well as meaningful participation, across the continuum of education.

7. Science for Fun Program

Science for Fun is a STEM program that brings parents and children together to explore and learn science in an engaging and fun way (Eley 2016). The aim is to inspire children and their parents to engage in science and to contribute to the development of their science capital through family science (Bell 2020). It is designed to enhance children's investigatory, problem solving and critical thinking skills. It introduces parents to basic scientific principles and concepts in a non-threatening environment, supporting them to facilitate hands-on science investigations with their own children and peers in the classroom

setting. This approach has been previously tried and tested by HSCL coordinators and teachers in Irish schools as outlined in Ryan and Lannin (2021).

The program was designed and delivered by academics in Sociology and Educational Disadvantage (N = 1) and STEM education and outreach (N = 2). It also involved preservice elementary teachers, in their third year of a four-year undergraduate degree, taking an elective course devoted to developing understanding and competencies in building family, school and community partnerships.

The Science for Fun workshops were designed to incorporate the three pillars of the science capital teaching approach (Godec et al. 2017). Pillar 1: Personalising and localising (making the science content personally relevant to the everyday lives of the parents and children and exploring how the work of parents/guardians might involve electricity); Pillar 2: Eliciting valuing and linking (making valued contributions by sharing relevant examples of how they interact with electricity and magnetism in their personal lives); and Pillar 3: Building science capital dimensions (working scientifically together, how the use of electricity and the uses of magnetism have developed over time and family science skills) (Poole 2018).

A Science for Fun session can be designed around any scientific topic. In consultation with the class teachers and the home-school-community liaison (HSCL) coordinators in each school, the concepts of electricity and magnetism were chosen as the focus of this program (Ryan and Lannin 2021). The children and parents would have experiences of these scientific phenomena either in their personal everyday lives and/or in their professional lives and are key scientific concepts included in the Irish elementary science curriculum for this age group. The topics of electricity and magnetism allow for the incorporation of a wide variety of hands-on investigations in the classroom. The preservice teachers and parents facilitated a variety of investigations through a circuit of station activities, exploring key concepts of electricity and magnetism. Each station was set up where a pair of preservice teachers, along with one or two parents, worked with a group of four to five children. The children moved from station to station, so that each parent and preservice teacher had the opportunity to work with every child in the class. Activities were chosen to promote curiosity and enjoyment, and to encourage children to develop a lasting interest in science, exploring the world around them, and thus increasing not only their science capital but also their social and cultural capital. The workshops encouraged problem solving and critical thinking, which are transferable skills across many life situations.

A spiral approach was taken when designing the station activities, whereby the children increased their understanding about a topic from one station to the next. As previously mentioned, the concepts of electricity and magnetism chosen would be familiar to many parents and children through their diverse range of experiences in their everyday lives. The real-world relevance, applications, and familiarity with the topics aimed to stimulate curiosity amongst the children, but also confidence among the parents, many of whom would not have specifically studied or felt confident in delivering such scientific information. The topics also allowed conversations to develop around socio-scientific issues, for example, renewable energy sources. This 'hands-on, minds-on' learning approach and how it relates to the lived experiences of the children is highlighted as a key principle of learning, teaching and assessment in Ireland's new Primary Curriculum Framework (Department of Education 2023) and in the draft Science, Technology and Engineering Education Curriculum Specification (National Council for Curriculum and Assessment (NCCA) (2024)).

Prior to working with the parents in the school environment, the preservice teachers (n = 30) received two laboratory sessions (2 × 2 h) to develop their understanding of the content and pedagogy required to facilitate hands-on investigations on the concepts of

electricity and magnetism. The students had studied science previously during two core science courses in their program of study. The Science for Fun preparatory sessions placed an emphasis on learning with parents, incorporating elements from the three pillars of the science capital teaching approach.

In the school setting, before each Science for Fun workshop, the preservice teachers facilitated a preparatory session (30 min each) with parents in which they explored the scientific content and age-appropriate pedagogies that they would co-facilitate during the workshop. These interactive and supportive mentoring sessions allowed parents time to explore the materials, ask questions and develop their science capital and confidence in the delivery of the specific science investigations.

Following program completion, the children were provided with STEM kits to use at home, based on their learning experiences during their Science for Fun activities. These kits were intended to allow parents and children to continue their engagement with science in the home environment (Bell 2020).

8. Research Methodology

Limerick is one of Ireland's fastest growing cities with its population set to increase by 50–60% to over 141,000 by 2040. Some areas of Limerick city and county have been identified as some of the most disadvantaged areas in Ireland, and Limerick city and county is also home to over 150 nationalities and cultures. The three elementary schools involved in the Science for Fun program were selected based on their high levels of socioeconomic disadvantage (Table 1) and are included in the Irish DEIS[4] scheme for disadvantaged schools. All three schools have been designated as DEIS Urban Band 1 schools, indicating that they are among the most disadvantaged schools in the scheme. Large numbers of children from the Irish Travelling community also attend the participating schools and they were our target group for this program. Eighty-eight third grade pupils (aged 9–10 years) were involved, and all children's parents were invited to participate, of whom less than half took part (N = 32). Home-School-Community Liaison (HSCL)[5] coordinators indicated that the parent participation rates were similar to those for other parent engagement activities in the school.

Table 1. Participants and schools involved in the Science for Fun program.

Type of School	Location and DEIS Status	HP Social Deprivation Index 2022	No of Preservice Teachers	No of Class Teachers	No of Children	No of Parents
Mixed School	Urban City School-DEIS Urban Band 1	Very Disadvantaged	10	2	34	12
All-girls Elementary School	Urban Town School-DEIS Urban Band 1	Extremely Disadvantaged	10	1	26	9
All-boys Elementary School	Urban Town School-DEIS Urban Band 1	Extremely Disadvantaged	10	1	28	11

9. Data Collection

The data collection methods, i.e., reflective questionnaires, were designed to obtain specific in-depth information from the preservice teachers on their first-hand subjective experiences of the Science for Fun program (Creswell 2015; Patton 1990). A phenomenological approach was adopted, describing the lived experiences of the participants (Cohen et al. 2011). Gathering data from the preservice teachers about their experiences was essential to capture

their voice in determining the evolutionary process for the Science for Fun program. This feedback is now being used to inform future iterations of the initiative (Miles et al. 2020).

10. Reflective Questionnaires

Thirty third-year undergraduate preservice elementary teachers undertaking an elective course on school, family, and community partnerships participated in the initiative. Data were collected through a two-part structured reflective questionnaire completed following each Science for Fun workshop. Full responses, to both parts of the questionnaire, were received from 23 preservice teachers (77%). Ethical approval for this data collection was covered under the Mary Immaculate College Ethics Committee (MIREC) application A22-018 regarding Education Outreach activities.

The research questions that were explored through the reflective survey included the following:

- What were preservice teachers' attitudes and concerns about working with parents and did these change/alter as a result of participating in the Science for Fun program?
- What did preservice teachers learn from the Science for Fun experience?
- Following participation in Science for Fun did preservice teachers understand the value of family, school and community partnerships for their future practice as teachers?
- How can this Science for Fun initiative inform the integration in teacher education programs of field-based experiences for preservice teachers relating to family, school and community partnerships?

11. Data Analysis

Preservice teachers' qualitative reflective responses (n = 23) were analyzed by systematically examining the participants' narratives to uncover patterns and themes. Researchers first familiarized themselves with the data by reading each reflective questionnaire several times and noting possible themes (Ashworth and Lucas 2000). Predominant themes were highlighted in each individual reflection, using the students' own words, ensuring that themes were grounded in students' experiences.

Codes were then assigned to portions of data and later organized into categories which were then presented in a series of themes (Saldaña 2021). This involved two researchers coding the data independently from one another. Coding of data involved an iterative process, involving code development and code application by re-reading, coding and recoding and identifying potential relationships between initial codes and instances where they could be merged. The researchers then compared their coding stripes and resolved any discrepancies by either changing the code or establishing a new agreement on the narrative (Cole 2023). Barratt's broad framework towards creating an approach for conducting qualitative data was used as a guide (Barratt et al. 2011). This was very useful to guide the researchers in how to evaluate the level of agreement between the two sets of coding and to reconcile differences.

This process of constant comparative analysis of the data allowed for the final five broad themes to emerge (Charmaz 2014).

- Attitudes and concerns about engaging parents in classroom activities;
- Preservice elementary teachers' learning from their Science for Fun experience;
- Realizing diversity across parents;
- Benefits for children's learning;
- Implications for preservice elementary teachers' future practice.

The use of inductive data analysis using rigorous coding methods ensured that the data reflected the participant voices (Braun and Clarke 2013; Charmaz 2006). The codes

and themes that were identified as a result were reflective of the content of the data in order to best represent what was being communicated by the students (Braun and Clarke 2013).

The researchers were also mindful of the limitations of 'self as instrument' in data analysis for qualitative research (McCracken 1988, p. 19). While it is impossible to eliminate researcher bias completely, the researcher limitations were reduced through ongoing monitoring of personal assumptions and beliefs, to determine their impact on both the collection and analysis of the data (Finlay 2009).

12. Findings

The responses of preservice teachers to this learning experience overall were very positive. They reported that they had learned a lot as well as having enjoyed the experience. The following summarizes the responses of preservice teachers to their changes in attitudes in relation to engaging with parents in the classroom, key learning they identified, and implications for their future work as teachers.

12.1. Attitudes and Concerns About Engaging Parents in Classroom Activities

In reflecting on their first Science for Fun workshop, all but one respondent (n = 22) stated that before the workshop they had been apprehensive, nervous, worried, and unsure about working with parents. The main concern expressed by all respondents was about how to relate to parents. Typical responses included "speaking to parents on a one-to-one basis would be very daunting" and "I was concerned about how we were meant to communicate with the parents effectively" and "I did not want to come across as condescending". Some expected that parents and children might be uninterested in the activities and difficult to engage, while others were concerned about using appropriate methodologies: "I was worried the parents would not trust my abilities to teach science as the electricity topic is one I often struggle with". Despite these concerns, the preservice teachers looked forward to the experience and were excited to meet the children. They also expected that the children would be excited to have their parents in the classroom, as was the case.

Following the first Science for Fun workshop, all 23 respondents were overwhelmingly positive about their first experience of working with the parents and looked forward to the second session. They indicated that, overall, they had overcome their fear of parents and working with parents and instead had begun to view parents as assets to their work rather than as potential problems. They also realized how interested the parents were in their children's learning and could see that they had valuable contributions to make. Their responses are instructive:

> "*Working with parents is not something to be afraid of and is a valuable asset for promoting the child's education. It is ok to be a bit nervous, as the parents are nervous too. Once communication is developed, it is clear that the parents themselves want to learn and participate in their child's education*".

> "*I feel quite positive about working with parents after the session. It has given me a different outlook on the role of parents within education and the benefits that it provides to the children*".

> "*The parents suggested interesting ways to make the circuits work, which were strategies that I had not previously thought of*".

12.2. Key Preservice Teachers' Learning from the Experience

Key learning for preservice teachers included overall awareness and openness to their role of involving parents. They gained a broader perspective on parents' roles in education and agreed that parents had valuable insights to share with them about their children. They also understood the potential benefits for following up school learning at home and gained

insights into the parent–child relationship as expressed in these comments: "...when their child was in our group, I could see how much they loved their child" and "many of the parents had to take some time off work to participate, which just shows how much they care about their children and their education".

The importance of the parent–teacher relationship and the potential of classroom-based activity for developing these relationships was also evident to participants:

> "*I learned how positive teacher-parent relationships can be . . . and how valuable getting parents into the classroom can be. At one point in the session I noticed that one parent was a bit anxious and moved to the side. This gave the classroom teacher the opportunity to chat to the parent and to make her feel welcome in the classroom*".

> "*After the session, we sat and spoke with the parents and it was insightful to hear how much they want and try to be involved in their children's education, and the work that the class teacher was doing to establish positive relationships between school and home*".

In relation to communicating with the parents, most preservice teachers noted that the first few minutes were 'awkward' but that it became easier as the session progressed. They indicated that the focus on the science activities helped to 'break the ice' and some noted that asking parents about their children was a positive way to build connections and it was also an area with which they were confident themselves. Some respondents noted that their own outgoing personality as well as the personality of the parents was a factor in the ease with which they could communicate with each other while other respondents made very deliberate efforts to overcome their own reserved personality but found that it was easier during the second workshop as they developed this practice.

12.3. Realizing Diversity Across Parents

Following the two Science for Fun sessions, preservice teachers felt equipped to make parents feel welcome. They now realized that all parents are different and require a variety of supports and that building trust between parents and teachers takes time:

> "*There were a lot of different personalities among the parents. Some were very outgoing and were keen when it came to showing them the content by asking questions and giving insightful ideas. Others were shy and more introverted, and it was clear that they were out of their comfort zone. Those parents simply observed when we were showing the children the activities. However, we were delighted they were showing up, as they were willing to make the effort to learn*".

> "*Some will be more inclined to engage with you than others. I learned that it may take longer for some people to feel they can trust you*".

There was also evidence that preservice teachers developed greater understanding of some parents' need for knowledge of how to support their children:

> "*Sometimes I believe parents may not value school or put in as much effort with their child's education as others. Although some parents do not give the same commitment, I now realize it is not that they do not care, it is just that they are unsure how to help them*".

Another preservice teacher reported that they increased their understanding of the possible fears faced by parents in relation to schools and the need for teachers to respect parents' fears and to try to put parents at ease. One advised, "*Don't pressurize them*".

12.4. Benefits for Children's Learning

There is extensive research evidence that confirms positive relationships between parent engagement and students' academic achievement (Sheldon 2019). Considerable research has examined children's academic outcomes in literacy and mathematics but

there are relatively fewer studies of the effects of parent engagement on children's science learning (Ibid). While this study did not directly measure children's science learning, all 23 respondents were impressed by the children's excitement and enthusiasm at having their parents present in their classroom: "Even though not every child's parent could attend, all of the children were excited about the parental presence in the classroom". Research by Harackiewicz et al. (2012) (cited in Sheldon 2019) proposed that the attitudes of parents about science have a significant effect on their children's motivation and attitudes to science and all 23 respondents in this study observed this positive impact on the children. For example, one respondent reported, "Having the parents show an interest in science meant that the children knew science was important", while another noted, "The growth in self-confidence of the child whose parent was leading the activity was clear". This also links to the discussion on building science capital earlier in this paper.

Some of the observed learning benefits for children in this science-focused program included "The children learnt about electricity from the parents in an enjoyable and engaging way. Not only did the learning occur, but the children had increased attention levels and great fun". Another respondent indicated higher levels of student engagement: "Their [the children's] need to impress the parents pushed them to problem solve".

12.5. Implications for Preservice Teachers' Future Practice

Following their participation in just two Science for Fun workshops, all 23 respondents were aware of the benefits of building positive relationships with parents and of the need for them as teachers to take the initiative in this:

> "*I will continue to be mindful how significant it will be for me as a classroom teacher to take on the role of establishing relationships with parents from the very first day they drop their children to school*".

> "*I understood how beneficial parental involvement can be from the lecture content this semester; however, I think that this experience helped me to really see this in action*".

Participants also understood the need for clear and positive communication with parents:

> "*I will do my best to keep parents informed on what the children are learning and to positively communicate with parents*".

Respondents all identified the positive outcomes that accrued from having the parents involved in class-based learning:

> "*I will try to incorporate parental involvement in the classroom as much as possible in my future teaching, encouraging parents to get involved when they can through open communication and trust*".

13. Other Outcomes Reported

This STEM education outreach program with parents was a positive and enjoyable learning experience for the preservice teachers, parents and children involved. One preservice teacher noted, "After the session we spoke with parents, and they spoke about how positive this experience was for them and how different it was from when they were in school".

Informal feedback from one principal identified the Science for Fun workshop as one of the highlights of the children's school year. A class teacher informed us that one boy had stayed behind with his grandmother when his parents left to travel in Europe because he did not want to miss the following week's session.

Several class teachers who observed the workshops requested copies of the workshop materials to run similar sessions for other classes in the schools and principals viewed Science for Fun as promoting the school's parent engagement work.

14. Discussion

Implications for Teacher Education

Finding time for courses on school, family and community partnerships in overloaded teacher education programs is a common challenge worldwide. The timing of such courses within a program is also a consideration since greater maturity and school-based experience help preservice teachers to better understand the complexities of family backgrounds and contexts, and the extent of parents' roles (Ryan 2024). There is also a need for teacher education on school, family and community partnerships across the continuum of teacher professional development from preservice to in-service (Epstein 2005, 2018; Miller et al. 2013) since it is expected that greater understanding and expertise develop over the course of a teacher's experience (Alanko 2018).

The importance of interdisciplinarity and collaboration has been highlighted in teacher education programs worldwide (Morris and Izumi-Taylor 1998; Epstein 2018). This Science for Fun parent engagement program is a good example of such interdisciplinary collaboration across sociology of education/DEIS and STEM education program areas. Further interdisciplinary practices are desirable but difficult to achieve within crowded teacher education programs. Integrating the practice of parent engagement across a range of subject pedagogy courses (e.g., literacy, mathematics, arts, social studies) would strengthen the message to preservice teachers that this approach is part of their professional work as teachers. It would also encourage teachers to make connections between their instructional practices and to build in parent engagement, both in the classroom and in innovative home learning or homework policies (Epstein and Van Voorhis 2012). For this to happen, it is necessary to provide information to and convince a broad range of teacher educators of the benefits of family, school and community engagement. This could be informed by the work being done in schools worldwide and there are very good examples of practice available from the National Network of Partnership Schools (Epstein 2019). Collaborations that fit within a school strategy for parent engagement and with the overall school and classroom instructional plan should also be prioritized (Epstein 2019; Epstein and Boone 2022).

These findings inform how to expand ways to support beginning teachers to develop their knowledge, skills and positive attitudes to building partnerships with parents. Providing practical experiences with families and communities (Uludag 2008) in a school environment is a big challenge, particularly in programs preparing large cohorts of up to five hundred preservice teachers. Intensive support and preparation by faculty members is required to enable preservice teachers to work cooperatively with parents and children on any curricular initiative.

Experience and research indicate the importance of interactive, discursive and reflective approaches in developing preservice teachers' beliefs and assumptions about school, family and community partnerships, often requiring time for the transformation of previously held beliefs and practices (Epstein 2018; Ryan and Lannin 2021). Participation in this program produced convincing changes in preservice teachers' attitudes about school, family and community partnerships and their skills and commitment to incorporating it in their future role as teachers. These reported outcomes are congruent with the family engagement core competencies developed by the National Association for Family, School, and Community Engagement (NAFSCE 2022), specifically within the Reflect domain.

The Science for Fun program helped preservice teachers to build relational, communication and context competences as identified by Westergård (2013). Significant learning that fits within the NAFSCE (2022) domains of Connect and Collaborate was also evidenced by preservice teachers' observations about how they communicated with parents and their learning to focus conversation topics on the children. It should also be noted that for this

program the preservice teachers, parents and children were all unknown to each other, which made the interactions more of a challenge for all involved.

15. Conclusions

Following the Science for Fun program, all respondents reported more positive attitudes to engaging parents in class-based learning with their children and stated that they had overcome their fears in relation to collaborating with parents. This built on work they had completed at the outset of the elective course on identifying their assumptions and attitudes to partnership with parents (Pushor and Parker 2013; Mapp et al. 2019). Preservice teachers also reported having developed skills to do this work; for example, they were more confident in their communication and relational skills (Ryan 2021; Westergård 2013) and they also gained skills in how to organize classroom activities with parents. The knowledge, skills and dispositions reported by respondents are congruent with the core competencies for family engagement developed by the National Association for Family, School, and Community Engagement (NAFSCE 2022), particularly within the domains of Reflect, Connect, and Collaborate. As outlined above, all participants identified their own key learning from the experience, and many noted key learning for the children also. They also identified aspects of partnership work that they plan to use in their future teaching.

In the future, it may be beneficial to support preservice teachers further in identifying what they need to learn (Kramarski and Kohen 2016) so that they may identify more specific learning goals. For example, participants indicated no awareness of overall school policy in relation to school, family and community partnerships. It could be argued that the experience of interacting with parents helped the preservice teachers to understand their role in fostering and developing school–family partnerships. The challenge for teacher education will be to explore the potential of permitting preservice teachers to meet and talk with parents, as this is currently not common practice (de Bruïne et al. 2018; Evans 2013; Saltmarsh et al. 2014; Willemse et al. 2016). While this Science for Fun program provided a field-based experience with parents for thirty preservice teachers, it would be difficult, if not impossible, to replicate this with the larger cohort of 450, due to staffing considerations as well as the capacity and willingness of schools to accommodate those preservice teachers. However, in consultation with schools, teachers and parents, it would be possible for preservice teachers to observe and discuss partnership practices with class teachers, including preparation for parent–teacher conferences.

Other approaches adopted by the first author of this paper include role play in class with preservice teachers taking on the roles of teachers and parents in a parent–teacher conference using case study scenarios adopted from practicing teachers. Parents have also been invited to speak to preservice teachers about their experiences of family–school partnerships in relation to their children's school learning and development. Another worthwhile activity is for preservice teachers to interview a parent they know about their communication with teacher(s) and school(s) and these findings may then be used as the basis of class discussions comparing actual school-based practices with recommended practices for family, school and community partnerships. Finally, case studies, such as those developed by Weiss et al. (2014), may be adapted for each specific international context to provide the basis for interactive discussions and problem-solving among preservice teachers.

16. Limitations and Needed Research

Data gathered for this study were limited to 23 preservice teachers' reflections on their experiences in three elementary schools. Expansion of this work would identify if and how the findings were consistent for other groups of student teachers across gender and other factors. Further research should also include feedback from parents and pupils about their

experiences of Science for Fun. It would also be interesting and useful to follow up with the participating preservice teachers about their experiences of family, school and community partnerships when they have begun their teaching careers.

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Notes

1 The term 'parent' is used throughout this article to include any adult (i.e., biological, adoptive, foster parent, guardian or family member) who takes responsibility (legal or otherwise) for a child's learning, development and wellbeing.

2 Teachers Involve Parents in Schoolwork (TIPS) is a research-based interactive homework approach to increase parent–child conversations about schoolwork (Epstein 2019).

3 Irish Travellers are an indigenous ethnic minority group who have a distinct identity, language, value system and a long-shared history. They are the most marginalized group in Irish society and face many challenges such as discrimination and lack of support to encourage pathways in education and into employment.

4 The DEIS (Delivering Equality of Opportunity in Schools) scheme (Department of Education and Skills 2017) is comprised of a standardized system for identifying levels of disadvantage in schools throughout Ireland, intended to reduce the risk of educational failure among children from socioeconomically disadvantaged homes. DEIS targets resources to schools as well as targeting resources within schools to students most in need (Weir et al. 2017). The Department of Education uses data from the Pobal HP Deprivation Index (Haase and Pratschke 2017) that covers the small areas (SA) from recent census data to determine the levels of disadvantage of schools. Schools are then designated as Urban Band 1 (most disadvantaged), Urban Band 2, or Rural. Further information is available at https://www.gov.ie/en/circular/cf319-deis-delivering-equality-of-opportunity-in-schools-action-planning-and-grant-allocation-for-all-deis-schools/. (accessed 9 January 2025).

5 A HSCL coordinator is a teacher who is not assigned teaching duties but has the role of working intensively with and providing support to parents/guardians with the goal of improving educational outcomes for children. Further information is available at https://www.tusla.ie/tess/hscl/. (accessed 9 January 2025).

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