STEM FAMILY LEARNING IN THE COMMUNITY

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NCI Tionscnamh Luathfhoghlama Early Learning Initiative

Taighde Éireann Research Ireland

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Acknowledgements:

ELI's development and achievements in STEM Family Learning and the building of science and wider educational capital within our communities, as outlined in this report, are the result of sustained cross-sectoral collaboration with our network of partners, adding a unique value to our programmes. Together we do so much more than this or any report can document to support at-risk children and families across Dublin's Inner City, with the learnings shared with other marginalised communities across Ireland. We would like to thank all our wonderful partners for their sustained support and acknowledge the following in particular.

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Contents

Executive Summary

Overview

The Early Learning Initiative (ELI) at the National College of Ireland (NCI) delivers a family-centred, community-based STEM learning model in Dublin's North Inner City (NIC), an area characterised by significant socio-economic disadvantage and a diverse population.

A large number of parents in the area are early school leavers and, as Growing Up in Ireland (2012) has found, not as well positioned to support their children's progress through the education system and onto employment. While local parents have high educational aspirations for their children, they are not confident that they have the skills to help their children to go on to further and higher education (Dartington Social Research Unit 2006). The Trinity Evaluation found that the ELI had succeeded in developing the knowledge and skills of parents through the development of networks of supports and knowledge sharing (Share et al 2011). Increasing the educational capital and expectations within families and communities is a central element of all ELI programmes (ELI, 2012).

For children to succeed, their parents need a positive local community educational network and infrastructure, which will give them the support they require to develop their parenting skills and support their children through the education system.

STEM Family Learning in the Community aims to increase access, build confidence, and support sustained engagement in STEM among children and families who may otherwise be excluded.

STEM learning is provided through a developmental continuum from early childhood to adolescence. It features throughout all ELI programmes from birth to college, and is the core focus of the four dedicated programmes that make up STEM Family Learning:

- STEM Family Events (0+)
- STEM Play & Learn (3–7 years, home visiting)
- Junior Coding Club (7–12 years)
- Senior Coding Club (13–16 years)

Delivery is underpinned by play-based learning, parental involvement, and low-cost, accessible activities, supported by a Community Action Research approach that enables continuous adaptation to community needs.

Informed by our work on educational capital (Bleach, 2011), this report focuses specifically on the concept of *science capital* (Archer et al., 2013), which highlights how families' knowledge, attitudes, experiences, and social networks shape engagement with science.

Aim of the Report

This report evaluates the impact of STEM Family Learning programmes on:

- Children's engagement, skills, and aspirations
- Parental confidence, attitudes, and involvement
- Family and community participation in STEM

It examines programme evaluation data with findings from two research projects to identify key outcomes, barriers, and enabling factors.

Summary of Methodology

A mixed-methods, participatory design was used, combining programme evaluation with standalone research.

Programme evaluation (CAR approach):

- Parent and child pre- and post-evaluations
- Formative assessments (e.g. quizzes and Kahoots)
- Facilitator and home visitor reflections

Research projects:

- Parental Attitudes to STEM and Digital Technology Study (2024–2025):
  13 interviews + survey (n≈157) examining attitudes, confidence, and digital engagement
- Family Case Studies (2025):
  5 in-depth interviews exploring participation pathways, motivations, and barriers

Data were analysed using descriptive statistics and thematic analysis, providing both outcome measures and explanatory insight.

Key Findings

Programme Impact

- Consistently high levels of engagement and enjoyment across all programmes
- Significant increases in parental confidence in supporting STEM learning
- Positive outcomes for children, including:
  - Increased interest and enjoyment in STEM
  - Improved skills (e.g. coding, problem-solving)
  - Stronger educational aspirations

Parental Attitudes and Confidence

- Strong belief in the importance of STEM for children's futures
- Limited initial understanding, often linked to negative school experiences

- Clear shift towards viewing STEM as:
    - Everyday
    - Play-based
    - Accessible

Family Learning and Engagement

- Parents act as co-learners, not just supporters
- Children's curiosity is a key driver of engagement
- Programmes strengthen home learning environments and parent–child interaction

Community Educational Network

- Trust and relationships are the primary entry point and driver of sustained family engagement in STEM programmes
- Word-of-mouth spreads participation creating a "ripple effect" across families, streets, and neighbourhoods
- Local, accessible delivery supports inclusion and builds supportive learning environments for both parents and children

Science Capital

- Builds confidence through exposure to STEM
- Shifts perceptions of STEM to everyday and accessible recognising it as everyday, relevant, and achievable
- Ongoing participation supports the development of STEM identity ("STEM is for me"), influencing aspirations, engagement, and long-term participation pathways

Digital Technology and AI

- Parents recognise benefits for learning and access
- Simultaneous concerns about overuse, safety, and wellbeing
- Confidence in supporting digital learning is uneven

Motivations for Participation

- Trust in ELI staff is the strongest driver of engagement
- Participation influenced by:
    - Relationships and word-of-mouth
    - Children's enjoyment and progress
- Programmes function as both learning and informal parent education

Barriers to Participation

- Time constraints and competing family demands
- Language and communication barriers
- Limited awareness of programmes
- Capacity constraints (e.g. waiting lists)
- Variability in parental confidence

Key Recommendations

Programme Development

- Expand capacity to meet demand
- Strengthen progression pathways across programmes
- Increase flexibility in delivery (timing, format, location)

Parental Support

- Provide structured supports to build confidence (e.g. practical demonstrations, STEM 101)
- Enhance guidance on STEM and digital learning at home
- Expand supports for navigating digital and AI environments

Access and Inclusion

- Strengthen outreach beyond existing networks
- Expand multilingual and culturally responsive provision
- Continue small-group, relationship-based delivery for inclusion

Workforce Development

- Invest in staff training and STEM/STEAM capacity building
- Support delivery of inclusive and accessible learning approaches

Policy and Funding

- Sustain long-term funding for family-centred STEM programmes
- Embed family learning within national STEM strategies
- Support scaling of evidence-based, community models

Conclusion

The findings demonstrate that STEM engagement is shaped by access, confidence, and sustained support rather than ability alone. ELI's approach shows that family-centred, relational, and developmentally aligned programmes can successfully build interest, engagement, skills, and aspirations.

By positioning parents as co-learners and embedding STEM within everyday life, the programme contributes to building family-level science capital: capability, confidence, and long-term participation in STEM, offering a scalable model for inclusive practice.

1. Background

The National College of Ireland (NCI) is a higher education institution committed to its mission of "changing lives through education," with a strong emphasis on widening participation and supporting learners from diverse and underrepresented backgrounds. Central to this mission is the Early Learning Initiative (ELI), a non-teaching department that extends NCI's impact beyond traditional higher education through community-based engagement and early intervention.

ELI responds to persistent educational disadvantage and social inequality that begin in early childhood and often compound across the life course. Children in disadvantaged communities are more likely to experience poverty, lower educational attainment, poorer health outcomes, and reduced access to opportunities. Families often face interconnected challenges, including financial pressure, limited access to services, social isolation, and reduced confidence in navigating education systems. Without early, coordinated support, these inequalities can become entrenched, affecting children's learning, wellbeing, and future life chances.

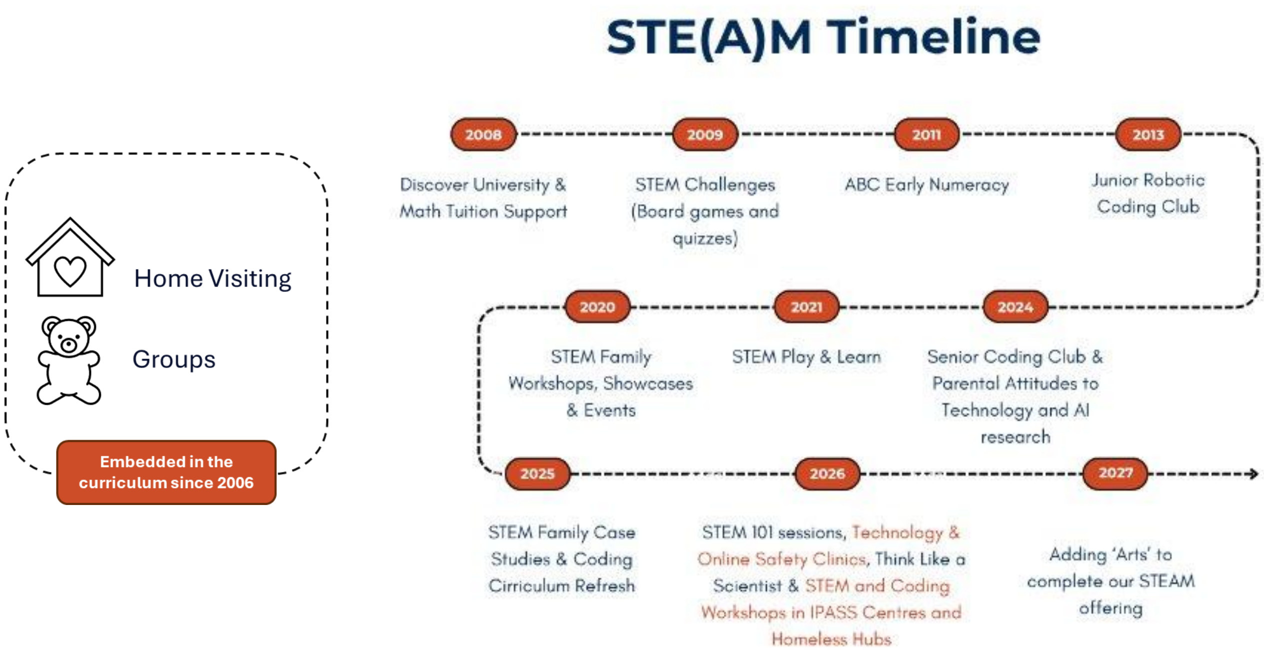
In response, ELI partners with communities and government stakeholders to deliver evidence-informed prevention and early intervention programmes from birth to college. These include home visiting, early learning support, literacy development, and parental engagement initiatives. Together, they create accessible pathways into education for families who may otherwise be excluded, strengthen family capacity, and promote positive educational expectations within communities.

A defining feature of ELI's approach is its use of Community Action Research, ensuring that programmes are responsive to local needs, co-created with families, and continuously refined through the integration of data and lived experience. This model supports ongoing programme improvement while generating insights that inform research, policy, and practice within NCI and beyond. The relationship between ELI and NCI is mutually reinforcing. ELI contributes real-world evidence and community perspectives, while NCI provides the academic infrastructure and strategic direction to sustain and scale impact.

ELI's STEM Family Learning model builds on this foundation through a community "living lab" approach that integrates programme delivery, research, and continuous evaluation. Developed over seven years of interdisciplinary collaboration with NCI's School of Computing and School of Psychology, the model provides sustained STEM learning pathways from early childhood to adolescence, with a strong emphasis on parental involvement, play-based learning, and the development of family science capital. It builds on nearly two decades of community-based provision, evolving from early numeracy and school readiness initiatives into a comprehensive, longitudinal STEM model.

A large number of parents in the area are early school leavers and, as Growing Up in Ireland (2012) has found, not as well positioned to support their children's progress through the education system and onto employment. While local parents have high educational aspirations for their children, they are not confident that they have the skills to help their children to go on to further and higher education (Dartington Social Research Unit 2006). The Trinity Evaluation found that the ELI had succeeded in developing the knowledge and skills of parents through the development of networks of supports and knowledge sharing (Share et al 2011). Increasing the educational capital and expectations within families and communities is a central element of all ELI programmes (ELI, 2012).

Within this framework, STEM Family Learning is a key strand of ELI's work, supporting children and families particularly those experiencing socio-economic disadvantage, including in Dublin's North East Inner City (NEIC) to engage with science, technology, engineering, and mathematics in meaningful and accessible ways. The initiative ignites and sustains positive STEM identities through hands-on, curiosity-driven learning and creates inclusive opportunities for families to build confidence, competence, and a sense of belonging in STEM and the wider research and innovation ecosystem.



STEM is embedded across ELI's continuum of supports, including Home Visiting programmes (ages 0–3), STEM Play & Learn sessions (ages 4–6), Coding Clubs (ages 7–12), Senior Coding Clubs (ages 13–16), and wider family-based STEM events. Central to this approach is the recognition of parents' critical role in shaping children's learning, outcomes, and aspirations. Through local advocacy, family learning, and sustained parental engagement, the programme contributes to building science capital and resilient communities. Informed by ELI's Community Action Research approach including findings from the 2024 Parental Attitudes to STEM and Digital Technology study and 2025 in-depth case studies on barriers and motivations, STEM programming is continually refined to respond to community needs.

1.1 Community Context

ELI's STEM Family Learning programmes are delivered in Dublin's Inner-City, which is one of Ireland's most transient and disadvantaged communities. Despite rapid growth and development in the area, transient, disadvantaged communities coping with years of intergenerational poverty, educational disadvantage, and immigration remain. Evidence from ELI's STEM Family Learning Programmes demonstrate how years of support, relationship building, collaboration, and multiple ongoing innovations work for at-risk children, families, communities, and Government. Our work is critical in sustaining Ireland's most vulnerable children's STEM skill development. It strengthens the research understanding of STEM engagement and cultural cognitive frameworks in marginalised communities.

Families we support are often juggling adverse socio-economic circumstances, children with additional needs, language, and literacy challenges in their daily lives (Bleach, 2024). STEM is not something they are familiar with or feel they are a part of, although, even with the current headlines about job cuts due to investment in AI, the elements of STEM are critical for many third level and career opportunities in Ireland. (National Skills Strategy, 2021). We are intentionally working to broaden participation and equity of access to STEM with this project by promoting the participation of socially, economically, and educationally disadvantaged population groups, supporting greater gender balance, disabled and neurodiverse children and under-represented racial and ethnic minority groups. Our programmes facilitate community members disconnected from research, innovation, and science, to engage in approachable, relevant experiences that get them interested and excited and start to build their science capital.

The multiple project elements continue to drive cross sectoral, bottom-up approaches to STEM learning for children from birth up to 16 years old and nurture cultural and science capital through inclusive and accessible education, building resilient families and sustainable communities. STEM learning is reimagined, and interest and excitement is created about STEM throughout the community (ELI, 2022). Successful change is complex. Initial findings from the 2024 Research Ireland (formerly Science Foundation Ireland) research on parental attitudes to STEM and digital technology underline how deep parents' feelings of inadequacy, intimidation and fear of STEM are, and how little confidence they have in their own STEM skills and their ability to support their children. It highlights how important the ongoing opportunities have been to them as their children progress through the school system. Engaging with multiple programmes over time enables educationally disadvantaged participants to be more comfortable, confident, and competent in the world of STEM.

What Makes the ELI STEM Family Learning Model Distinct

It's not just what we do, how we do it is just as important.

- Community-embedded delivery
- Parent peer champions and home visitors
- Free, accessible, and flexible programmes
- Multilingual, neurodiverse-friendly approaches
- Play-based, inquiry-led pedagogy
- Continuous evaluation and reflection

2. Aim of the Report

This report evaluates the impact of the STEM Family Learning programmes on children, parents, and community engagement, and identifies factors influencing participation and outcomes. It encompasses both programme-level evaluation and two discrete research projects, integrating findings from community action research within programme delivery alongside insights generated through qualitative interviews and a quantitative survey. Together, these approaches provide a comprehensive assessment of programme effectiveness, participant experiences, and the broader contextual factors shaping engagement and impact resulting in the development and sustainment of family science capital.

2.1 Theoretical Foundations: Educational Capital, Science Capital and STEM Identity

Educational Capital

Educational capital—closely linked to Bourdieu's (1977) concept of cultural capital—refers to the knowledge, skills, confidence and social resources that enable parents to support their children's educational journeys (Bleach, 2010). Educational achievement remains strongly associated with socio-economic background, as families with higher levels of education possess the "educational and intellectual capital" to guide learning, navigate the system and provide enriched learning opportunities at home. In contrast, findings from the Dartington Social Research Unit (2006) show that while parents in disadvantaged communities such as Dublin's NIC often have high aspirations, they frequently lack the confidence and knowledge to translate these into effective support for their children. This gap is reflected in the powerful parental voice captured in an ELI programme evaluation:

"I love my children; I want them to do well. I don't know how. ELI helps me with how."

By building parents' skills, networks and engagement, initiatives such as ELI strengthen educational capital within families and communities, enhancing the home learning environment and ultimately improving children's educational outcomes and aspirations.

Building educational capital is a complex and non-linear process that requires sustained engagement over time. This is further compounded in STEM contexts, where there is often a lack of parental role models, with low proportions of parents holding STEM qualifications (20-25% across programmes), limiting exposure to science-related knowledge and pathways. Progress is often uneven, particularly in communities characterised by high levels of mobility, where families may move in and out of programmes, and participation can fluctuate. In addition, parents frequently face competing demands on their time and resources, which can limit consistent engagement despite strong aspirations for their children, highlighting the need for flexible, responsive and relationship-based approaches.

Science Capital

Science capital can be understood as a domain-specific extension of educational capital (Bleach, 2010), referring to the science-related knowledge, skills, experiences and social resources that influence engagement with STEM. While educational capital captures parents' broader capacity to support learning, science capital focuses more specifically on familiarity with science, access to STEM-related experiences, and confidence in supporting children's learning in this area. In this way, strengthening science capital both draws on and contributes to the development of wider educational capital within families and communities.

The concept of *science capital* provides a central framework for understanding how engagement with STEM is shaped by a combination of science-related knowledge, dispositions, experiences, and social networks (Archer et al. 2015). It moves beyond ideas of ability to emphasise that participation in STEM is influenced by access to opportunities, levels of confidence, and the extent to which STEM is perceived as relevant to everyday life. Central to this is the development of STEM identity—children's sense of whether "science is for me"—which is formed early and shaped within family and community contexts.

STEM affinity is a predictor for future success

STEM affinity—confidence, competence, and engagement in science, technology, engineering, and mathematics—builds Science Capital. Identified by Professor Louise Archer (2009), Science Capital is linked to positive life outcomes, including good health, job satisfaction, and active citizenship, regardless of gender, ethnicity, or income (Archer, 2023). It also correlates with being in education, employment, or training at age 21. Rooted in the Aistear framework, which emphasizes early learning as foundational (2023), ELI's 0–5 home visiting programmes involve families in STEM from birth (Bleach, 2024). Programmes for older children build on this foundation, showing increased interest, skills, and confidence (Darmody et al., 2022, 2023). Our focus on parental science capital and involvement is also known to be powerful for their children's sustained interest in STEM (Šimunović, M., & Babarović, T., 2020).

STEM education is a national priority to support future economic growth and development

Ireland's STEM Education Policy (2019–2026) highlights STEM's role in preparing young people for active citizenship, critical engagement with media, and informed life choices. A child's early learning and ability in Science, Technology, Engineering, and Mathematics (STEM) is a strong predictor of future success, both academically and in a range of careers, including emerging fields such as artificial intelligence (AI) (Hinjosa et al., 2016). However, student access to and participation in STEM education and careers varies with socio-economic factors (Shaw & Barbuti, 2010). In 2020/21, fewer than 10% of third-level graduates in Ireland were from disadvantaged backgrounds, and even fewer graduated in STEM fields (O'Shea, 2023). Research shows that task mastery, role models, and positive experiences enhance self-efficacy (Bandura, 1997; Schlegel et al., 2019). To shift this dynamic, NCI's involvement promotes STEM-related careers, breaks down barriers and negative stereotypes, and provides opportunities for positive STEM experiences and task mastery (Kracen, 2023 and Mothersill et al., 2024).

This perspective is reinforced by the parental socialisation model (Eccles et al., 1983), which highlights how parents' beliefs and values influence children's motivation, competence, and educational aspirations through everyday interactions and behaviours. Parents' confidence in engaging with STEM is particularly important, as self-efficacy theory (Bandura, 1997) suggests that individuals who feel capable are more likely to engage, persist, and create supportive learning environments.

Learning in Context: Sociocultural and Ecological Perspectives

These processes are further understood through sociocultural and ecological theories of learning. Vygotsky's (1978) theory emphasises that children develop understanding through guided interaction with more knowledgeable others, while Bronfenbrenner's (1994) bioecological model situates learning within interconnected systems, including family, school, and community environments. Together, these frameworks highlight that STEM engagement is relational and context-dependent, shaped through ongoing interactions within the home and wider community.

Taken together, these perspectives provide a coherent theoretical foundation for this work, illustrating how exposure to STEM experiences, parental confidence, and culturally relevant learning opportunities contribute to the development of science capital and, in turn, to children's engagement, identity, and long-term participation in STEM.

3. Methodology

Research Design

This work adopted a mixed-methods, participatory research design combining community action research (CAR) within programme delivery and participatory mixed-methods inquiry across two discrete research strands. This approach ensures that participant voices, particularly those from underrepresented communities, inform both programme development and research outcomes (Bleach, 2013, 2016).

The methodology comprised two interconnected components:

1. *Programme-Level Evaluation (STEM Play and Learn, STEM Family Events, Junior, and Senior Coding Clubs):*
   A community action research approach was employed to evaluate individual programme elements, enabling iterative improvements grounded in stakeholder feedback.
2. *Standalone Research Projects:*
   This research is a cross-departmental collaboration between ELI, and NCI's School of Computing, and School of Business.
   a. Parental Attitudes to STEM and Digital Technology (2024-2025) explored parental attitudes and awareness of STEM and AI in depth. Interview questions were developed based on the theoretical framework provided by Eccles et al. (1983), known as the parent socialisation model. According to this model, parents' beliefs and values influence parenting behaviours, which in turn influence children's competence, and beliefs.
   b. Family Case studies (2024-2025) explored parents' motivations and barriers to STEM participation for their children. Semi-structured interview questions were developed by the project team informed by the findings from the parental attitudes interviews and surveys.

Community Action Research in Programme Delivery

STEM Play and Learn, STEM Family Events and the Coding Clubs were assessed using a community action research framework, characterised by cyclical processes of planning, action, observation, and reflection. This approach was selected to ensure responsiveness to the needs of participating children and families and to support continuous programme refinement. Evaluation questions have evolved over time as have the curriculums for these programmes.

Data Collection Methods

Multiple data sources were utilised to capture holistic programme impact:

- **Parent Pre- and Post-Evaluations**
  Structured questionnaires were administered to parents/guardians before and after participation. These captured changes in:
    - Confidence in supporting STEM learning at home
    - Understanding of STEM
    - Desire to be more involved in their child's STEM learning
    - Enjoyment and engagement levels
    - Perceptions of learning value of the programme

- **Child Pre- and Post-Evaluations (where appropriate):**
  Age-appropriate instruments (including visual scales and short questionnaires) were used to assess changes in:
    - Improvement in coding and computer skills
    - Confidence in coding and computer skills
    - Third level education expectations
    - Enjoyment and engagement levels

- **Formative Assessment via Kahoots:**
  Interactive quizzes embedded within coding sessions served both pedagogical and evaluative functions. These tools:
    - Measured incremental knowledge acquisition
    - Provided real-time feedback to facilitators
    - Supported inclusive engagement through gamified learning

- **Home Visitor/Facilitator Reflections:**
  Facilitators and Home Visitors maintained structured reflective logs documenting:
    - Session/visit dynamics and child/parent engagement
    - Observed learning outcomes
    - Challenges and adaptations
    - Contextual factors affecting participation

Analytical Approach

Quantitative data from pre- and post-evaluations and quizzes were analysed using descriptive and comparative statistics to identify patterns of change. Qualitative data from facilitator reflections were subjected to thematic analysis, enabling the identification of recurring themes related to engagement, inclusivity, and programme effectiveness.

Participatory Mixed-Methods Research Projects

Two standalone research projects were conducted to complement programme-level evaluation, each employing participatory principles to centre the experiences of community stakeholders.

Methodology

- Establishment of a Research Oversight Group
- Gaining ethical approval
- Survey design in consultation with parents and home visitors
- Interview design
- Face-to-face interviews, using a bespoke questionnaire, with both qualitative and quantitative research questions
- Extension to ethical approval for Case Studies
- Survey design
- Face-to-face interviews, using a bespoke questionnaire, with both qualitative and quantitative research questions

Parental Attitudes to STEM and Digital Technology including AI (13 Qualitative Interviews and an online Microsoft Forms survey)

We conducted thirteen semi-structured interviews (three pilot and ten main interviews) with parents based in Dublin's North Inner City, seven interviews conducted in person in National College of Ireland, and 6 interviews conducted online over Microsoft Teams, in July 2024. Interviews were recorded using a Dell Laptop running Microsoft Teams, recordings were automatically transcribed using Teams, and transcriptions were reviewed by a member of the research team to make sure they matched the recordings. Interview transcripts were analysed using thematic analysis, which involved familiarisation with the data, generating initial codes highlighting common patterns of meaning, generating broader themes covering multiple codes, reviewing themes, and defining and naming themes (Braun and Clarke, 2006).

Sampling:
Participants were purposively selected to ensure diversity in terms of engagement levels, demographic background, and prior experience with STEM.

Data Collection:
45-60 minute Interviews conducted in person and online

- **Parental awareness and understanding of STEM and digital technology**, including their knowledge, definitions, and sources of information about these areas.
- **Parental attitudes and beliefs towards STEM, digital technology, and education**, including perceived benefits, challenges, and the role of STEM in their child's learning and development.
- **Parental behaviours and practices related to digital technology use at home**, including how parents use technology themselves, how they support or limit their child's use, and joint parent–child technology activities.

- **Perceived barriers, supports, and future considerations for STEM learning**, including obstacles in school, supports needed, and awareness of emerging technologies such as Artificial Intelligence (AI).

- **Pilot Phase:**
  An initial pilot of the interview protocol was conducted to:
  - Refine question clarity and sequencing
  - Ensure cultural and linguistic accessibility
  - Minimise potential bias or leading questions

- **Analysis:**
  Interview data were transcribed and analysed using **reflexive thematic analysis**, allowing for both inductive and deductive coding.

Quantitative Survey

A broader **survey instrument** was developed to capture trends across a wider participant group.

- **Design:**
  The survey included a combination of:
  - Demographic questions
  - Closed-ended questions
  - Likert-scale items

- **Pilot Testing:**
  The survey was piloted prior to full deployment to:
  - Assess reliability and comprehension
  - Ensure appropriateness for the target population
  - Refine question wording and structure

- **Distribution:**
  The survey was disseminated through participating families and associated networks to maximise reach and inclusivity.

- **Analysis:**
  Quantitative data were analysed using descriptive and inferential statistics, while open-text responses were analysed using content analysis to complement numerical findings.

Five Parent Case Studies to understand motivations and barriers to their children participating in STEM programmes with ELI

We conducted five semi-structured interviews with parents based in Dublin's North Inner City, four interviews conducted in person in National College of Ireland, and one interview conducted online over Microsoft Teams in 2025. Interviews were recorded using a Dell Laptop running Microsoft Teams, recordings were automatically transcribed using Teams, and transcriptions were reviewed by a member of the research team to make sure they matched the recordings. Interview transcripts were analysed using Co-pilot assisted thematic analysis, which involved familiarisation with the data, generating initial codes highlighting common patterns of meaning, generating broader themes covering multiple codes, reviewing themes, and defining and naming themes (Braun and Clarke, 2006).

Sampling:

Participants were purposively selected to ensure diversity in terms of engagement levels, demographic background, and prior experience with STEM. There was no duplication with the parents from Project 1.

- Chinese father of 4-year-old boy
- Chinese mother of 5-year-old girl
- Irish mother of an autistic 5-year-old boy and a one-year-old girl
- Irish mother of autistic 5-year-old boy
- Irish father of three children

Data Collection:

45-60 minute Interviews conducted in person and online

- Parents' pathways into choosing STEM programmes, including how they became involved, their level of participation, and whether engagement is influenced by recommendations or word-of-mouth.
- Motivations, enablers, and barriers to participation, exploring why parents choose STEM programmes, what encourages involvement, and what challenges may prevent engagement.
- Parents' perceptions and prior experiences of STEM, including their own experiences growing up, how their views have changed, and how current programmes compare to their past exposure to STEM.
- Perceived impact and future engagement, including benefits for children's learning, continued involvement in STEM education, and how programmes can better support families going forward.

Analysis:
Interview data were transcribed and analysed using reflexive thematic analysis, allowing for both inductive and deductive coding.

Ethical Considerations

All research activities adhered to ethical standards consistent with institutional guidelines. Ethical approval for the two research projects was granted by the National College of Ireland Ethics Committee on the 23rd of May 2024 (Ethics Approval Number 23052404).

- Informed consent was obtained from all participants, with parental consent secured
- Participation was voluntary, with the option to withdraw at any stage
- Data were anonymised to ensure confidentiality and data protection compliance (GDPR)
- Methods were adapted to ensure accessibility and inclusivity, particularly for participants with English as an additional language.

4. Literature Review and Policy Context

This literature review examines the significant role of parents in shaping children's engagement with STEM learning, with particular attention to how attitudes, perceptions, and access influence early experiences. Drawing on established developmental theories and contemporary STEM education research, the review situates the home as a critical context for early learning, where parent–child interactions can support both cognitive and socio-emotional development. It also explores how parental confidence, prior experiences, and beliefs about STEM can either facilitate or constrain children's opportunities to engage with STEM in meaningful ways. In addition, the review considers issues of equity and access, recognising the structural barriers faced by families in disadvantaged communities, as well as the growing importance of digital and emerging technologies in children's lives. By integrating these perspectives, the review provides a foundation for understanding the importance of family-based, accessible, and play-oriented approaches to STEM learning within both policy and practice.

Parents' influence on children's development and STEM learning

Parents have a profound impact on children's learning, interests, and educational outcomes. From an evolutionary standpoint, parental involvement has played a crucial role in the survival and development of offspring. Bronfenbrenner's bioecological systems theory highlights how children's development is shaped through interactions within their immediate environment, particularly with caregivers and family members (Mercan et al. 2022; Bronfenbrenner 1994). Similarly, Vygotsky's Sociocultural Development Theory (1978) emphasises that children learn through guided interaction with more knowledgeable others, particularly within meaningful social contexts.

These theoretical perspectives are strongly supported in STEM education literature, which positions the home as a critical site for early STEM learning. Research shows that parent-guided interactions in everyday contexts enhance children's early STEM understanding, language development, and problem-solving abilities (Thomas et al. 2020; McClure et al. 2017).

Importantly, exposure to STEM does not need to occur through formal instruction. Research shows that play-based activities, everyday conversations, and shared exploration provide meaningful opportunities for children to engage with STEM concepts (Fleer, 2016;

McClure et al., 2017). Informal, parent-facilitated learning experiences—such as discussing natural phenomena or engaging in hands-on play—support both children's conceptual understanding and language development (Thomas et al., 2020; Newman et al., 2016). This reinforces the importance of parental awareness and confidence in fostering children's early engagement with STEM.

Defining attitude and perception

An attitude is defined as "a mental or neural state of readiness, organised through experience, exerting a directive or dynamic influence on the individual's response to all objects and situations to which it is related" (Pickens 2005). In other words, attitudes reflect an individual's mindset, shaped by prior experience. Perception, similarly, describes how individuals interpret stimuli based on those experiences (Pickens 2005).

These concepts are particularly important in STEM engagement. Research suggests that parents' perceptions of STEM—as difficult, academic, or inaccessible—can influence both their own engagement and their child's exposure to STEM learning opportunities (Mercan et al. 2022).

Parental influence on children's engagement in STEM

Parental beliefs and attitudes play a critical role in shaping children's engagement with STEM. A study by Sonnenschein and Dowling (2017) found that parents with positive attitudes towards mathematics were more likely to foster interest and persistence in their children. Similarly, Thomas et al. (2020) found that parental beliefs about STEM are predictive of children's achievement in science and mathematics.

Beyond attitudes, parental involvement provides children with opportunities to practice and engage with STEM concepts. However, many parents report lacking confidence in their ability to support STEM learning, particularly when they perceive it as requiring specialist knowledge. This can lead to avoidance of STEM-related activities in the home.

Emerging research highlights that increasing parental confidence and providing simple, accessible tools can significantly enhance engagement. Short-term interventions and programmes that support co-learning between parents and children have been shown to improve both parental self-efficacy and children's engagement (Francis 2019; Thomas et al. 2020).

Parents' relationships with STEM

Francis (2019) identifies two key factors shaping parents' relationships with STEM:

1. Recent experiences with STEM learning
2. Personal educational history

Parents who have had positive recent experiences particularly through participation in programmes with their children are more likely to integrate STEM activities and concepts into everyday life. This aligns with findings from STEM Play & Learn research, which show that parent participation in guided activities increases confidence and encourages continuation of learning at home (Francis 2019; ELI Evaluation Report 2023).

Conversely, parents with limited exposure or negative educational experiences with STEM may perceive it as inaccessible or irrelevant. However, programmes that emphasise creativity, play, and real-world application can shift these perceptions. Research on STEAM (integrating the arts into STEM) demonstrates that creative approaches broaden engagement and make STEM more culturally relevant and appealing to families (Walshe 2024).

The importance of early STEM education and play-based learning

Research consistently highlights early learning as the foundation for all subsequent learning (Heckman, 2006) and consistently shows that early STEM engagement is strongly linked to later academic and life success. Early mathematical ability, in particular, is a strong predictor of long-term achievement (Duncan et al. 2007, Bleach, 2015).

STEM learning in early childhood contributes to both:

- Domain-specific skills, such as numeracy and spatial reasoning
- Domain-general skills, such as executive function (working memory, inhibition, and cognitive flexibility) (Center on the Developing Child 2020; Di Lieto et al. 2020)

Evidence from intervention studies further illustrates these developmental benefits. A meta-analysis by Di Lieto et al. (2020) found that children aged 5–6 who participated in structured robotics activities, such as Bee-Bot programming, demonstrated statistically significant improvements in working memory and inhibition control. These findings highlight the potential of early, play-based STEM experiences to actively support executive function development. Importantly, such gains may be particularly impactful for children from disadvantaged backgrounds, for whom gaps in executive functioning are often more pronounced, suggesting a role for early STEM interventions in reducing developmental inequalities.

Play-based learning is widely recognised as the most effective approach for early STEM. Activities such as block play, water exploration, and simple experiments support cognitive development and are strongly associated with later STEM interest and achievement (Newman et al. 2016; Fleer 2016).

Importantly, guided play—where adults scaffold children's thinking through questioning and interaction—has been shown to significantly enhance learning outcomes, reinforcing the significant role of parents in early STEM development (Thomas et al. 2020).

Equity and access in STEM education

Children from disadvantaged communities face significant barriers to STEM engagement, including limited access to resources, lower parental familiarity with STEM, and fewer opportunities for experiential learning (Mercan et al. 2022).

These inequalities can widen over time, particularly during school holidays, when learning loss disproportionately affects children from low-income households (Cooper et al. 1996; McCoy et al. 2021).

Programmes that are home-based or community-based, use low-cost materials, and support parent engagement, have been shown to effectively reduce these barriers and support equitable access to STEM learning (ELI Evaluation Report 2023, Alcala, Et al., (2024).

Parental influence on children's wellbeing in the digital world

As children develop relationships with digital technologies, parental influence remains critical. Research shows both positive and negative impacts of digital engagement. While excessive use is linked to reduced physical activity and developmental challenges, digital technologies can also enhance confidence and engagement when used appropriately (Internet Matters 2022).

Children tend to have more positive digital experiences when their parents are actively involved, suggesting that co-engagement and boundary-setting are key factors in healthy digital development.

Parents' beliefs also influence when and how children are introduced to technology. Hammer et al. (2021) found that parents who value technology are more likely to introduce devices earlier, which can increase children's digital confidence. However, balancing digital and non-digital activities is essential for overall wellbeing.

Assessing attitudes towards AI

The AI Attitude Scale developed by Grassini highlights how trust, optimism, and individual characteristics influence perceptions of AI. Gender differences have been observed, with males reporting more positive attitudes towards AI. Trust and transparency also play significant roles in shaping public attitudes (Grassini; Stein, Jan-Philipp et al. 2024).

These findings reinforce the importance of education and communication in shaping attitudes towards emerging technologies, particularly for parents supporting children in a rapidly evolving digital landscape.

Extending existing research to Dublin's inner city

While existing research demonstrates the importance of parental involvement in STEM and digital learning, many studies are limited by sample bias and lack representation from disadvantaged communities.

The Early Learning Initiative (ELI) addresses this gap by providing accessible, community-based STEM programmes that integrate family engagement as a core component. ELI's approach aligns with research highlighting the importance of parent-child co-learning, culturally responsive delivery, and play-based, accessible STEM experiences

By supporting parents to develop confidence and positive relationships with STEM, ELI not only enhances children's learning outcomes but also strengthens long-term engagement with education. This approach reflects broader research findings that parental confidence and involvement are key drivers of children's STEM participation and success (Sonnenschein & Dowling 2017; Thomas et al. 2020).

Irish Policy Context

Ireland's policy landscape reflects a strong and evolving commitment to STEM education as a driver of social inclusion, economic development, and lifelong learning. The national STEM Education Policy Statement 2017–2026 emphasises the importance of fostering creativity, critical thinking, and problem-solving skills, while also prioritising increased participation among underrepresented groups, including those from socioeconomically disadvantaged backgrounds. This focus aligns with the objectives of the Delivering Equality of Opportunity in Schools (DEIS) strategy, which aims to mitigate educational disadvantage through targeted supports and interventions, recognising that early engagement is critical to improving long-term educational outcomes. In parallel, national lifelong learning policies highlight the need to build skills across the life course, supporting individuals and families to engage with education beyond formal schooling. Together, these policy frameworks underscore the importance of accessible, community-based STEM initiatives—such as family learning programmes—in promoting equity of access, strengthening educational pathways, and supporting inclusive participation in an increasingly knowledge-based society.

STEM Family Learning also aligns with the National Skills Strategy (2025) and contributes to the UN Sustainable Development Goals, particularly SDG 4 (Quality Education), SDG 5

(Gender Equality), and SDG 1 (No Poverty), reinforcing its role in promoting inclusive access to STEM learning.

5. Programme Overview

STEM Family Learning in the Community

STEM family learning in the community comprises four elements:

1. STEM Family Events (0+ years)
2. STEM Play and Learn (3-5 years)
3. Junior Coding Club (7-12 years)
4. Senior Coding Club (13-16 years)

Learnings generated through Community Action Research across these four STEM-focused programmes inform the design and delivery of all ELI programmes. This ensures that effective approaches to STEM learning for children and families are embedded consistently across the full programme continuum. Our initial approach was to provide children, parents, and families with multiple opportunities to interact with STEM resulting in a ripple effect through families, streets, neighbourhoods and communities. It is evident from the findings of our Barriers and Motivations case studies (see section 8, Research Project 2) that word of mouth, trusted recommendations and relationships are a key driver of programme participation. The first step towards improving educational outcomes for participants and in this case igniting their Science Capital.

STEM Family Events (aged 0+) | Started in 2020, 354 families engaged over the last six years

STEM events encourage family and community engagement with STEM activities and provide underserved families with ideas and skills that can be easily translated to the home environment. The events are designed to support parents to build their capacity as educators of their children and stimulate increased family interest, confidence, and participation in STEM. Events are delivered in collaboration with local services and other ELI programmes, thereby increasing awareness, curiosity, and confidence in the scientific method through relevant experiences.

STEM Family events started in person in 2020-2021 as card games and Lego events and then became virtual during the COVID-19 pandemic including topics such as 3D Printing, the environment, and sequence and pattern. Since 2023 as we went back to gathering in-person, these events have grown in size, and variety to include Science Week partnerships with the Amber Research Network at Trinity College, a STEM Carnival and Earth Day and Sustainability themed events using reusable resources and materials found easily at home mysteries. In 2025-2026 we commenced delivering family STEM and coding workshops in homeless hubs and IPAS centres. Evaluation data from these events will be available in our end of year report.

STEM Play and Learn (3-7 years) | Started in 2022, 71 families engaged over the last four years

STEM Play and Learn is an intensive 4–6-week summer home visiting programme, which supports and encourages the STEAM skills of our most vulnerable children and their families and combats summer earning loss. Drawing on Aistear, STEAM activities contribute to the enhancement of creativity, innovation, early numeracy, early science concepts, problem-solving, critical thinking and interdisciplinary skills in young children as well as support parents and families to provide a stimulating play-based home learning environment. This programme was developed during COVID-19 as an extension to our Stretch Graduate programme and is aimed at families who need continued support after home visiting when children are 0-3. Weekly activity packs include: an outdoor pack, kinetic sand, planting/gardening, mark making activity (especially good for non-verbal children), a sensory pack/game and a back-to-school pack.

Junior Coding Club (7-12 years) | Started in 2013, 951 children and 263 Parents engaged over the last 13 years

The Junior Coding Club is an 8-week programme delivered in collaboration with NCI's School of Computing, designed for at-risk children aged 7–12 years attending primary schools, after-school services, and youth programmes. The initiative introduces participants to fundamental computer programming concepts and terminology within a challenging, interactive, and engaging learning environment, using age-appropriate hardware and software. Through hands-on activities, children explore robotics, programming, and electronics using mBots, educational robots that enable them to build, code, and experiment thereby nurturing early engineering and computational thinking skills.

By increasing access to STEM learning opportunities, the Coding Club supports vulnerable children in extending and deepening their understanding of mathematical and scientific concepts in a positive and supportive environment that promotes digital literacy. Each programme culminates in a showcase event, where parents and families are invited to observe and celebrate their children's learning and achievements. In the 2025–2026 programme cycle, the curriculum was further enhanced to establish more explicit connections between STEM learning, robotics, and future career pathways, encouraging participants to recognise the relevance of STEM skills, confidence, and competence in shaping their future aspirations. Like the STEM Family events, Coding Club went virtual during the COVID-19 Lockdowns.

Senior Coding Club (13-16 years) | Started in 2024 | 76 children and 65 Parents engaged over the last two years.

The Senior Coding Club is an intensive, short-duration programme designed for young people aged 13–16 attending local secondary and after-school, youth services, delivered in collaboration with NCI's School of Computing. The programme introduces participants to Python programming through a structured, hands-on learning model that combines theory, practical lab sessions, and project-based learning using Raspberry Pi technology. Over the course of the programme, students develop key coding, computational thinking, and problem-solving skills while working collaboratively on real-world challenges.

A central feature of the programme is a team-based hackathon, where participants apply their learning to design and present projects to peers, educators, and industry representatives. The programme also actively involves parents through engagement activities and showcase events, strengthening support for STEM learning at home. By providing access to more advanced coding experiences, the Senior Coding Club supports young people in building digital skills, confidence, and awareness of STEM pathways, helping to bridge the gap between early exposure to coding and future education or career opportunities in technology.

6. Evaluation Findings (Programmes)

It should be noted that evaluation questions have evolved over time as the programmes have grown in complexity and in response to participant needs therefore some sample sizes/response numbers are smaller than others. In addition, delivering evaluations to participants can be challenging due to literacy, EAL challenges and form filling fatigue. Attendance is not always regular as families and children are frequently grappling with multiple complex challenges daily to get basic needs such as housing, food and medical care met. In programmes such as junior coding which ELI runs in schools and afterschool's, it has been historically challenging to gather feedback from parents as they have been unable to attend the showcase events due to work commitments. We are reliant on teachers and home school liaisons to support us in gathering the feedback and they are often time and resource poor. We are continually trialling diverse ways of making participation more accessible and evaluation forms easier to fill out while still gathering rich data. Lastly evaluation forms for younger children were shortened and simplified.

STEM Family Events (0+ years)

Evaluation findings from the STEM Family Learning programmes demonstrate consistently high levels of engagement, satisfaction, and perceived impact among participating families since its inception in 2020. Almost all parents reported that their child enjoyed the programme (99%, n=146), and a similarly high proportion identified it as a valuable learning opportunity (93%, n=138), indicating strong perceived educational benefit. A substantial majority of parents also reported increased involvement in their child's learning (89%, n=37), alongside high levels of increased child interest in STEM (86%, n=226). Importantly, participation had a notable impact on parental confidence, with 94% (n=12) stating they felt more confident supporting their child's STEM learning after attending an event. In addition, 93% of parents (n=40) reported improved understanding of STEM concepts, and 100% (n=10) recognised the importance of STEM skills for their child's future. While a smaller proportion of parents reported holding a STEM qualification themselves (25%, n=33), the findings suggest that the programme is effective in building knowledge, confidence, and engagement among families regardless of prior STEM background.

Feedback from parents:

"Is a great opportunity for my son to socialise and learn about recycling and STEM. He was away from screens and engaged in hands on activities." (2024-2025)

"I can't believe how engaged my child has been, he has literally spent 40 minutes sitting and concentrating (which he does struggle with usually) with that shaving foam and food colouring activity. This is something I can do at home easily with him." (2024-2025)

"Had a lot of fun today and got so many tips regarding sustainable and easy activities that I could use at home with my own children. Thank you for having us and we would love to come again." (2024-2025)

STEM Play & Learn (3-7 years)

Participation in the STEM Play & Learn programme demonstrates consistently strong positive outcomes across key parent-reported measures. Overall satisfaction is extremely high, with 93% (n=65) of parents reporting that they enjoyed the programme and 95% (n=66) that their child enjoyed the programme. Confidence outcomes are also strong, with 86% (n=51) reporting increased confidence in supporting STEM learning specifically after participation (an increase of 7% preprogramme). Reported improvements in children's skills are positive across all domains, including numeracy (80%, n=54), language (81%, n=54), social and emotional development (81%, n=53), and focus and concentration (81%, n=53). Perceptions of STEM's importance are particularly high, with 96% of parents (n=52) agreeing that STEM skills are important for their child's future. While outcomes remain consistently positive, skill-based indicators (e.g. language and concentration) show slightly lower agreement levels compared to satisfaction measures, suggesting an area for ongoing programme refinement, although it should be noted that a high proportion of programme children have additional needs (73% in 2024-2025) and may take more time to progress at a higher rate in these areas.   Overall, the findings indicate that STEM P&L is highly valued by families and supports both parental confidence and children's early STEM-related development.

Feedback from parents:

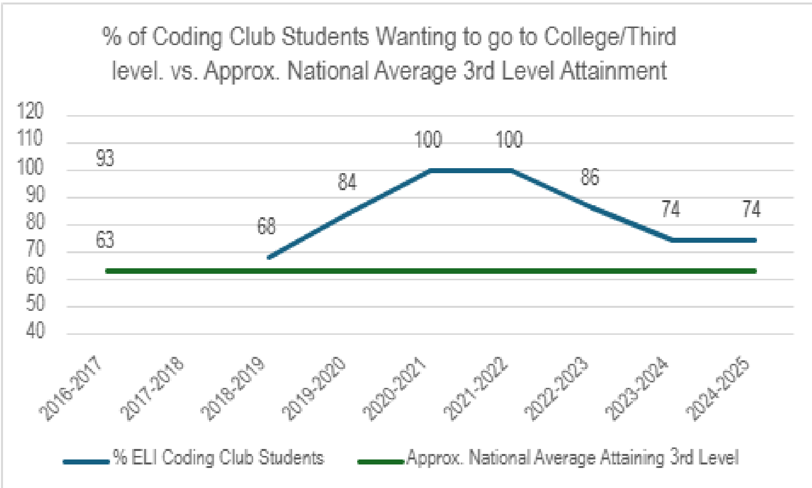
"STEM skills seem indispensable in helping our children to learn to navigate an increasingly complex society and give them a big advantage in securing their financial future." (2023-2024)

"I basically learned that everything we do on a daily basis can relate back to STEM." (2023-2024)

Feedback from Co-ordinators:

"I brought the Scavenger Hunt today. We looked for all the images on the list first, child was very excited running around and searching in the park, it was great to see he had a good time outside. Mam helped too, and they both enjoyed the activity, it was a great bonding experience for them." (2024-2025)

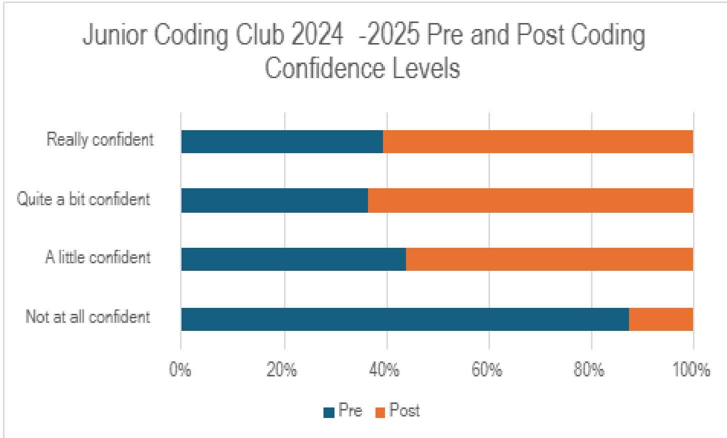
Junior Coding Club (7-12 years)

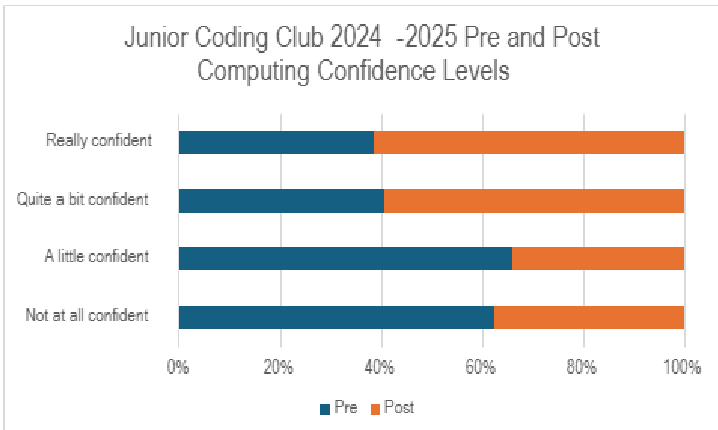


1 Third level data is from the Higher Education Authority and includes part-time, full-time, distance, e-learning and in-service students.

Participation in the Junior Coding programme demonstrates strong engagement and consistently positive outcomes for both children and parents. Overall enjoyment is high, with 87% of children reported to have enjoyed the programme (n=264) and 98% of parents indicating it was a valuable learning opportunity for their child (n=47). The programme also supports parental engagement and capacity-building, with 80% of parents reporting that they want to be more involved in their child's learning (n=95) and 81% feeling more confident in supporting their child's STEM learning (n=57). Children's interest in STEM is positively influenced, with 84% expressing a desire to learn more about STEM (n=95). Longer-term outcomes are particularly notable, with 85% indicating positive third-level aspirations (n=368), suggesting that participation is contributing not only to immediate engagement but also to shaping future educational pathways. This percentage is well above the average national third level attainment, currently 60-65% (CSO, 2022).

Beyond these strong satisfaction and aspiration outcomes, coding-specific evaluation data highlights substantial gains in children's confidence and skills development over time. Across recent programme years, children reported significant increases in confidence in both coding and broader computer skills, with some cohorts showing improvements of up to 78–81% in children feeling confident, alongside a reduction in those reporting low confidence levels. These confidence gains are supported by consistent evidence that children are developing practical digital and problem-solving skills, with many reporting improvements in their ability to code and use technology effectively.





High levels of enjoyment (typically over 90% in individual years) underpin these outcomes, reinforcing the importance of an engaging and supportive learning environment. Weekly Kahoot quizzes, assessing children's incremental knowledge gain reveal scores of over 80% for the first 5 weeks, dropping to 70% in the final weeks as questions become more technical and focused on advanced operation of the robot.

The findings also point to wider impacts beyond the individual participant. Parents report increased confidence and understanding of STEM, suggesting that the programme is contributing to a more supportive home learning environment and strengthening family-level engagement with STEM. At the same time, the combination of high enjoyment, growing confidence, and strong aspiration indicators highlights the programme's contribution to both short-term skill acquisition and longer-term educational ambition and development of science capital. Overall, the Junior Coding programme demonstrates a robust and sustained impact, effectively combining engagement, skills development, confidence-building, and aspiration-raising outcomes for children and their families.

Feedback from parents:

> *"It was really interesting and educational for my kid. I didn't even know if she would be interested or have these skills...thanks to coding club I found out." [Parent, 2022-2023]*

"Just how good it is and great that they can go on at home if they want to keep doing it."
[Parent, 2022-2023]

Feedback from Co-ordinators:

"One of the students I met at the Education Guidance Programme told me that after completing our coding sessions last year, she loved it so much that she started creating her own games using Roblox Studio." (2025-2026)

Senior Coding Club (13-16 years)

Participation in the Senior Coding Club demonstrates strong outcomes in continuing to build students' skills, confidence, and engagement with STEM. The programme significantly increased participants' confidence in both computer and coding skills, with those reporting being "quite" or "very confident" rising to 82% for computer skills (up from 29%) and 71% for coding (up from low baseline levels). All students reported improvements in their coding skills, while 86% noted enhanced computer skills and 69% reported increased interest in STEM, highlighting the programme's effectiveness in developing both technical competence and enthusiasm. Parental feedback further reinforces these findings, with 100% agreeing that the programme improved their child's STEM skills and the majority reporting increased confidence in supporting STEM learning and greater involvement in their child's education. Overall, the Senior Coding Club shows a strong impact in advancing digital skills, boosting confidence, and fostering sustained interest in STEM among older students, while also strengthening family engagement in learning.

Feedback from parents:

"Gives wider range of options on education and career choices." (2024-2025)

"STEM become a part of the living world, influencing every job field. The future will rely even more on these essentials skills; it's crucial to understand them now." (2024-2025)

7. Research Project Findings

Parental Attitudes to STEM and Digital Technology (Interviews)

Interviews

This section presents the findings from 13 qualitative interviews conducted with parents to explore their attitudes towards STEM and digital technologies. The data were analysed using a thematic approach, identifying recurring patterns and shared experiences across participants' responses. The analysis captures parents' understandings of STEM, their confidence in engaging with it, and how they perceive their role in supporting their children's learning.

Overall, the interviews reveal both commonalities and variation in parental perspectives. While some parents demonstrated confidence and awareness, many described limited understanding, uncertainty, or mixed feelings towards STEM and digital technologies. Despite this, there was a strong and consistent recognition of the importance of these areas for children's development and future opportunities. Across the interviews, parents also reflected on their everyday experiences, highlighting how children's interests, family routines, and access to information shape engagement with STEM-related learning.

The themes presented in this section reflect the lived experiences of parents and provide insight into how they interpret, value, and engage with STEM in both educational and home contexts. Parents have not engaged heavily with ELI's dedicated STEM programming and represent a broader sample of ELI's parent cohort.

1.Limited and Narrow Understanding of STEM

Across interviews, parents consistently demonstrated limited or partial understanding of STEM, often associating it with school subjects, technology, or technical expertise rather than everyday learning.

Some parents described confusion or fear, particularly linked to their own educational experiences:

"When you hear it… you're kind of like, oh God… I don't know enough. How do I deal with it?"

"I hear a fear… it was so scary… I thought I was going to have to sit down and do all these maths things."

Others reduced STEM to specific domains such as devices or formal education:

"Computers… tablets… more online stuff."

"All the things I wasn't good at in school."

However, once explained, parents often reframed STEM as accessible and embedded in daily life, aligning strongly with literature on informal, play-based STEM learning.

"Then when I actually took the time to sit and actually find out what it was… it actually intrigued me… STEM is everywhere… your kitchen… balloons can be brought into a STEM activity."

"When you actually get down to basics… it's as simple as a packet of mega blocks or playdough."

2. Parental Attitudes Shaped by Personal Experience

Parents' attitudes towards STEM were closely linked to their own educational histories and confidence levels. Negative school experiences—particularly in maths—continued to shape perceptions:

"I struggled with maths… so I'd probably back away from it (STEM)."

Others expressed low digital confidence, particularly beyond basic use:

"Very basic… it's not very intuitive for me to use. I do struggle."

At the same time, some parents demonstrated strong interest and awareness, particularly where they had professional or personal exposure or their children have an interest:

"My son… he really loves coding… he wants to pursue his career in computer science and AI… so I did have some little knowledge about that because he's very interested.

"I did my first part of my degree in coding and in computer science… I've a huge interest in technology… I build computers… I've troubleshooted them… you learn by doing."

This variation reflects literature findings that parental confidence and prior experience shape engagement but can be shifted through exposure and support.

3. Recognition of STEM as Important for Children's Future

Despite limited understanding, there was a very strong consensus that STEM is important for children's futures, particularly in relation to careers, skills, and societal change.

"It's very, very important for younger generation… technology is spreading too quickly."

"It's kind of the cornerstone… for careers for kids going forward."

Parents also emphasised:

- Lifelong relevance
- Problem-solving and thinking skills
- Preparation for a digital world

This aligns strongly with literature highlighting STEM as critical for future employability and adaptability.

4. STEM as Everyday Learning (Shift in Perception)

A major emerging theme is a shift from seeing STEM as academic to recognising it in everyday life, particularly through children's learning.

"STEM is everywhere… your kitchen… everyday things can be brought into a STEM activity."

"It's as simple as… blocks or playdough."

Parents also noticed children's natural curiosity:

"She wants to know all the 'why's'… it's all science."

This strongly reflects the finding in our case studies in the next section and the literature on play-based, informal STEM learning.

5. Parental Role: Supportive but Often Uncertain

Parents widely recognised their role in supporting STEM learning, but many reported lack of confidence or guidance.

"Parents don't always know how to guide children… they need to show us how."

"I wouldn't know enough to make sure I'm keeping them safe."

Parents often relied on:

- Partners
- Friends
- Online sources

"It's just… people around me showing me."

This aligns directly with literature describing Parental self-efficacy as a key factor and the need for guided co-learning and support

6. Digital Technology: Essential but Ambivalent

Parents expressed a strongly ambivalent view of digital technology, with nearly all participants (approximately 90–100%) identifying clear benefits such as convenience, communication, and access to information. At the same time, a similarly high proportion (approximately 85–95%) raised concerns related to overuse, reduced social interaction, and distraction from family life. This overlap suggests that digital technology is not viewed in binary terms, but rather as an essential yet challenging aspect of everyday family life. It should be noted that indicative proportions are based on qualitative analysis.

Benefits:

- Convenience and access 100%
- Communication 85-90%
- Independence/daily functioning 70-80%
- Learning support 75-85%

Concerns:

- Overuse and addiction
- Reduced interaction
    - Distraction from family time

"You get sucked in… two hours just go by."

"You're missing those valuable moments with the kids."

These findings reflect the literature on digital parenting tensions and the need for balanced engagement.

7. Children’s Interest and Learning as a Key Motivator

A central finding across the interviews is the powerful role of children’s natural curiosity and enthusiasm in driving parental engagement with STEM and digital learning. Parents consistently described how their child’s interest—rather than their own prior knowledge—served as the primary trigger for engagement with STEM-related activities.

“She’s really interested… she loves counting… she’s picking things up.”

“He really loves coding… he wants to pursue computer science.”

In many cases, parents positioned themselves as responding to, rather than leading, learning, with children acting as initiators of exploration and inquiry. This was particularly evident where children demonstrated sustained curiosity, such as asking questions, experimenting, or showing interest in how things work. These behaviours often prompted parents to:

- Seek out information
- Facilitate activities or opportunities
- Learn alongside their child

This highlights a bidirectional dynamic, where children’s engagement actively shapes parental attitudes and behaviours. Rather than parental knowledge alone driving children’s interest—as often suggested in the literature—the findings show that children can also act as catalysts for parental learning and confidence-building.

Importantly, this dynamic aligns closely with ELI’s approach, which emphasises co-learning and shared exploration. By using play-based, accessible activities, programmes such as STEM Play & Learn create opportunities for children to express curiosity in ways that are visible and meaningful to parents. This, in turn, encourages parents to engage, even where initial confidence may be low. As children demonstrate enjoyment, progress, and capability, parents become more motivated to sustain participation and incorporate learning into everyday routines.

Overall, the findings suggest that children’s interest functions not only as an outcome of effective STEM engagement, but also as a key mechanism for initiating and sustaining family involvement, reinforcing the importance of designing programmes that actively harness and respond to children’s natural curiosity.

8. Barriers: Knowledge, Confidence, and Access to Information

In addition to structural barriers identified in case studies, interviews highlight knowledge and awareness barriers:

- Lack of understanding of STEM
- Lack of guidance on how to support children
- Limited accessible information

"There's not a lot put out there to help learn more… I haven't found somewhere I can go."

Parents were particularly concerned about:

- Supporting learning at home
- Digital safety
- Keeping up with technological change

9. Role of Schools and External Programmes in Supporting STEM Engagement

Parents frequently highlighted the important role of schools and external programmes in introducing STEM concepts, building confidence, and supporting both children's and parents' engagement. For many families, schools represent the primary point of initial exposure, with children often bringing home ideas and activities that prompt further curiosity and discussion.

However, the interviews also revealed variation in the extent and consistency of STEM provision across schools. While some parents described positive experiences, others indicated that STEM is not always embedded within everyday teaching and may instead depend on individual teachers or specific initiatives. In these cases, STEM was perceived as:

- Occasional or supplementary rather than integrated
- Less prioritised compared to core subjects
- Inconsistently delivered across different settings

One parent, for example, noted that their child had *“lost out a bit in good STEM activities”* when provision was reduced, highlighting concerns about continuity and access.

Parents also expressed a clear need for more practical support and guidance, particularly in understanding how to extend STEM learning into the home. Rather than relying on written materials or general instructions, parents emphasised the importance of demonstration, explanation, and shared learning experiences that would enable them to feel more confident in supporting their children.

“They need to show the caregivers how to do it at home.”

“It should be more integrated… part of everyday lessons.”

Overall, the findings suggest that while schools play a key role in introducing STEM, there are gaps in consistency, integration, and support for parental involvement, which can influence how effectively learning is reinforced in the home environment.

10. Digital technology as an enabler for inclusion and additional needs

A notable finding across the interviews is the role of digital technology as a powerful enabler for accessibility and inclusion, particularly for parents and children with additional needs. For some families, technology is not simply a convenience but an essential tool that supports independence, communication, and participation in everyday life.

This is most clearly illustrated in the experience of one parent who is visually impaired, who described digital technology as central to their autonomy:

“Undoubtedly it improves my independence and my quality of life… to not be reliant on other people… technology bridges that gap.”

Similarly, other parents highlighted how technology can support children with diverse or additional needs, particularly in relation to communication and engagement. For example, one parent noted:

“Some children really, really do depend on them… for communication and that is amazing that they have that technology now.”

In contexts where children may experience challenges with sleep, attention, or regulation, technology was also described as a practical support:

“Technology is the only thing that kind of keeps him going… sometimes I need it to help him.”

These accounts highlight a more nuanced understanding of digital technology within families, where its value extends beyond learning and convenience to include accessibility, inclusion, and daily functioning. This contrasts with more general concerns about screen time, demonstrating that for some families, particularly those with additional needs, technology plays a critical and positive role in supporting both children and parents.

11. Attitudes to Artificial Intelligence

Responses to questions on artificial intelligence (AI) revealed a combination of emerging awareness, curiosity, and uncertainty among parents. While AI was not always well understood in technical terms, many parents recognised it as a rapidly developing area that is already influencing their children's experiences and future opportunities. In several cases, awareness of AI was driven by children's exposure through school or online content. For example, one parent described how their child was becoming increasingly engaged with the topic, noting they were *"seeing videos on YouTube… and thinking about… AI… robots,"* and were *"intrigued about that as well."* Similarly, others connected AI to broader future trends, describing how *"in future… you will see more robotic programmes everywhere,"* highlighting a perception of AI as an inevitable part of societal change.

At the same time, parents commonly expressed limited personal knowledge and a sense of needing to learn alongside their children, reflecting a pattern seen across wider STEM topics. AI was often framed as something important but abstract, understood in terms of its potential impact rather than its practical application. This lack of familiarity was coupled with a general sense of rapid technological advancement, which some parents found difficult to keep pace with. However, rather than expressing strong fear or resistance, parents tended to position AI within a narrative of opportunity, particularly in relation to future careers and skills development. Overall, the findings suggest that AI is viewed as highly relevant but not yet fully accessible to parents, with understanding often mediated through children's experiences and informal learning environments.

Conclusion

Taken together, the interview findings highlight a complex but consistent picture of how parents understand and engage with STEM and digital technologies. Across the data, engagement is shaped less by prior knowledge of STEM itself, and more by a combination of children's interests, parental confidence, and access to practical support and guidance.

A central theme is that many parents begin with a limited or narrow understanding of STEM, often associating it with formal education, technical subjects, or their own negative school experiences. This initial uncertainty can act as a barrier to engagement. However, the findings show that this perception is not fixed. When STEM is framed in accessible, everyday terms—particularly through children's activities or practical examples—parents quickly begin to reconceptualise STEM as something familiar, relevant, and achievable within the home.

Children play a critical role in this process. Across the interviews, children's curiosity, enthusiasm, and emerging interests acted as primary drivers of engagement. Parents frequently described responding to their child's questions, interests, or enjoyment of activities, often positioning themselves as co-learners rather than instructors. This highlights a bidirectional dynamic, where children's engagement not only reflects but actively shapes parental attitudes, confidence, and behaviour.

At the same time, parental engagement is strongly mediated by confidence and prior experience. Parents with professional, educational, or personal exposure to STEM or technology demonstrated higher levels of confidence and agency, while others expressed uncertainty about their ability to support their children. However, this gap was not insurmountable. The findings consistently show that parents are willing to engage when provided with practical, hands-on support and clear guidance, rather than abstract information.

Digital technology emerges as a particularly ambivalent but central feature of family life. Parents overwhelmingly recognised its benefits in terms of convenience, communication, learning, and independence, while simultaneously expressing concern about overuse, distraction, and reduced social interaction. This dual perception suggests that digital technology is experienced not as inherently positive or negative, but as an essential and often challenging part of everyday parenting. Notably, for some families—particularly those with additional needs—technology plays a critical enabling role, supporting independence, communication, and daily functioning.

The findings also point to variability in access and support, particularly in relation to formal education settings. While schools are a key entry point for STEM, parents described inconsistencies in how STEM is delivered, integrated, and extended into the home. Many parents expressed a need for more practical involvement, demonstration, and opportunities to learn alongside their children, highlighting a gap between school-based learning and home-based engagement.

Overall, the data suggest that participation in STEM is not primarily determined by parental knowledge or interest alone, but by a set of interconnected factors:

- children's curiosity and engagement
- parents' confidence and prior experiences
- access to clear, practical support
- and the extent to which STEM is framed as relevant to everyday life

Importantly, the findings reinforce the idea that STEM engagement is most effective when it is relational, experiential, and embedded within family routines, rather than presented as a formal or abstract subject. In this context, parents are not passive supporters but active participants in a shared learning process, where confidence and engagement develop over time through interaction, experience, and observation.

Survey

The findings from the survey dataset (n=157) reinforce and deepen earlier insights, showing consistently positive parental attitudes toward STEM learning alongside more nuanced variation in confidence, access, and digital engagement. Importantly, these attitudes emerge from a geographically and socio-economically diverse sample, strengthening the relevance of the findings across different contexts, and indicating that the trends observed reflect broad perspectives rather than a single community profile.

Across the survey, there is strong and widespread recognition of the value of STEM education for children's futures and wider society. Most respondents express agreement that STEM contributes positively to children's long-term opportunities and to societal advancement, with over 70% indicating agreement or strong agreement on these items. Similarly, there is high endorsement of statements highlighting STEM's role in improving quality of life and supporting informed decision-making. At the same time, negative perceptions—such as STEM being irrelevant to daily life—are consistently rejected, reinforcing a clear consensus that STEM is both meaningful and worthwhile.

A major theme emerging from the data is the perception that STEM is accessible, flexible, and can be embedded within the home environment. Between 75% and 90% of respondents agree that STEM activities can be carried out with children at any age and do not require specialised equipment or formal lab settings. Many parents also believe that STEM education can take place in everyday settings, aligning closely with the core aims of the STEM Family Learning programme to normalise and integrate STEM into family life. While some concerns about cost are present, a majority indicate that meaningful STEM engagement does not depend on expensive resources, suggesting openness to low-cost or informal learning approaches.

The findings on inclusion are particularly strong and consistent. More than 80% of respondents disagree with statements suggesting that STEM is only for boys or for gifted children, indicating a broadly inclusive mindset among parents. This suggests that key barriers historically associated with STEM participation—such as gender stereotypes—are being actively rejected by a substantial proportion of families. However, there is more variability when it comes to younger children, with some parents expressing uncertainty about the appropriateness of STEM for pre-school age groups, highlighting an area where further guidance and reassurance may be beneficial.

Despite these overwhelmingly positive attitudes, the survey reveals important variation in parental confidence and self-efficacy. While most parents report feeling confident in their ability to support STEM learning, typically around 60–70% expressing confidence, there remains a significant minority (approximately 20–30%) who report neutrality or lack of confidence in areas such as answering questions or preparing STEM activities. This gap between valuing STEM and feeling able to actively support it is a key finding. The data also indicates that confidence is strongly associated with levels of familiarity and educational background, with those reporting higher education or greater exposure to STEM and digital tools expressing more confidence in engaging with their children's learning.

The survey also provides valuable insight into digital technology use and attitudes, which closely intersect with STEM engagement. A clear majority of parents recognise the benefits of digital tools, with approximately 65–80% agreeing that technology supports their child's learning, skill development, and ability to access information. At the same time, responses reveal more varied experiences regarding digital wellbeing: around 40–60% of parents express concerns relating to issues such as excessive screen time, online safety, misinformation, and unhealthy social comparison. While many parents feel confident using digital devices themselves—typically 60–75% reporting confidence in their own digital skills—there is greater variation in their perceived ability to guide their children, with approximately 25–35% indicating neutrality or uncertainty in supporting safe and effective digital engagement. This points to an ongoing need for support in strengthening parental confidence in this area.

Patterns of access to technology further highlight both opportunity and inequality. The data suggests that a majority of children (approximately 70–85%) have access to at least one digital device, often from primary school age, and in some cases as early as 2–5 years old, reflecting early exposure across the cohort. However, there is clear variability in the level and quality of access: while some families report extensive access to books and digital resources (including high proportions reporting 50–100+ books or multiple devices), others report limited or no access, indicating a meaningful digital divide within the sample. This contrast reinforces the importance of ensuring equitable provision and targeted supports within programme design, particularly for families with lower levels of digital and resource access.

Attitudes toward artificial intelligence (AI) are broadly positive but still emerging. A large proportion of respondents report high agreement (often scores of 8–10 out of 10, representing over 75%) that AI will improve their lives and work, and that it will play a significant role in the future. This suggests openness to new technologies, although the depth of understanding and confidence in engaging with AI specifically appears more variable compared to general digital technologies.

Conclusion

Overall, the findings paint a coherent and encouraging picture. Parents across a diverse cohort value STEM highly, view it as accessible and inclusive, and recognise the benefits of digital technology for learning. However, there remains a consistent and important gap between positive attitudes and practical confidence, alongside variability in access to resources and digital support. For the STEM Family Learning programme, these findings highlight the importance of continuing to build parental confidence, provide practical and low-barrier resources, and support families in navigating both STEM and digital learning environments. By doing so, the programme can build on the strong positive foundation identified in this dataset and further enable parents to become active partners in their children's STEM learning journeys.

Case Studies looking at Parental Barriers to and Motivating Factors for STEM participation

Analysis of the five case studies highlights a consistent and interrelated set of motivations and barriers influencing family engagement in ELI STEM programmes. Overall, participation is driven primarily by relational and experiential factors, while barriers tend to be structural, logistical, and systemic in nature.

Motivations for Participation

Trust in ELI staff and established relationships

A central finding across all cases is that trust in ELI staff and established relationships is the most significant driver of engagement. Families do not typically engage because a programme is labelled "STEM", but because it is recommended by a trusted home visitor, facilitator, or school contact. This is particularly evident in one father's account, where initial engagement began through a single school-based activity ("Rummikub"), and developed into sustained involvement in STEM programmes through ongoing contact with ELI staff. Over time, this relationship-led engagement extended across all his children, with participation becoming embedded as part of family life rather than linked to any specific subject area. Similarly, across other cases, trusted practitioners played a key role in encouraging initial uptake and maintaining participation, with parents often describing automatic or repeated engagement once a relationship had been established. These findings suggest that relational trust not only facilitates access but also transforms participation into a sustained, family-wide practice, independent of the specific programme content.

"Anything that became available from the ELI programme, we just said 'sign me up'… it's helped with child's progress."

“If it’s ELI, we just go for it… if it wasn’t good, we wouldn’t keep doing it.”

“He always asks, ‘Is Lisa (Home Visitor) coming?’… he really wants to see her.”

“When he saw the home visitor, he became a different child… he’d try things with them he wouldn’t try anywhere else.”

“Rummikub – that started it all off… that’s how I met Julie and all the staff… and since then I’ve done every one.”

“I’ve done it with all of them… Emma first, then Dave, then Hannah… we’ve done the Rummikub, the Monopoly and the quizzes.”

Children’s enjoyment and visible progress

Closely linked to this is the role of children’s enjoyment and visible progress. Parents are strongly motivated to continue participating when they see their child engaged, confident, and developing new interests. This is particularly important for children with additional needs, where participation can lead to notable improvements in confidence, sensory engagement, and willingness to try new activities.

“It helped her try different things… she could find new things that she liked.”

“We were collecting rocks before – now we’re collecting leaves… I never would have thought to do that.

“He really loved the experiments… his face just lights up when he sees how things work.”

Another key motivation is parental learning and capacity-building. Parents consistently described STEM programmes as opportunities to learn how to support their child’s development, including how to ask questions, explain concepts, and turn everyday activities into learning experiences. This positions these programmes not only as a child-focused intervention but also as an informal parent education model.

"We learn from the teacher how to guide the kids… how to talk to them and explain things properly. Parents don't always know how to guide children… teachers (home visitors) show us how."

"It gave me ideas and ways of doing things with him that I never would have thought of."

"It just shows you how simple play can be… you don't need expensive things, just ideas and a bit of creativity."

Accessibility is also critical. Families are more likely to participate when programmes are free, home-based, or locally delivered, and use simple, low-cost materials that can be easily replicated. These features reduce barriers to entry and enable learning to continue beyond the structured sessions.

"Before, we just went to the playground… now we talk about what we see, like leaves or insects."

"We planted seeds at home and made a little garden… he checked it every day and was so proud of it."

"We still do the experiments at home… he asks, 'can we do that again?'"

Finally, continuity and progression play an important role in sustaining engagement. Families who previously participated in programmes such as ParentChild+ often seek a "next step", with STEM Play and Learn, STEM Family events or Coding providing a natural progression that maintains relationships while supporting children's ongoing development. Parents also value the role of STEM in supporting school readiness, early problem-solving skills, and positive learning behaviours.

"It was a really nice continuation from the two plus (ParentChild+) programme… we were kind of sad when it finished, so this was a great next step."

"I think she is more confident now… she understands how to learn and it helps her in school."

"He's learned to be more patient… to follow something through instead of wanting it straight away.

Barriers to Participation

The most consistently reported barrier is time and competing demands, particularly for working parents or families managing multiple children. Even where motivation is high, participation can be constrained by scheduling pressures and inflexible routines.

"Time and logistics can be hard, especially if you have more than one

Language and communication barriers also significantly affect access, particularly for migrant families. Limited English proficiency can prevent awareness of programmes and reduce confidence in engaging, unless mitigated through language-specific supports or bilingual staff.

"A language barrier could stop some parents… especially those who aren't confident in English."

"We chose ELI because they had Chinese-speaking staff… that made it easier for us to join and understand."

"They speak Chinese, so it's easy to communicate… if it's in English and you don't understand, it's just like blah blah… it doesn't make sense."

A related issue is low awareness of available programmes. Many families reported that they only became aware of STEM opportunities through direct, personal contact or word-of-mouth rather than formal promotion, suggesting that current outreach mechanisms may not reach wider or more isolated communities.

"The biggest thing is people not knowing about it… a lot of parents just haven't heard of it."

"We meet in the street, in the playground, in the library… we talk about what activities are on, and that's how we find out."

There are also barriers linked to programme design and format. Larger public STEM events can be overwhelming for younger children or those with additional needs, with families expressing a clear preference for small-group, home and relationship-based delivery. Additionally, some parents report low confidence, lack of interest, or competing priorities, which can reduce engagement, particularly among fathers or less-involved caregivers.

"What's great about the STEM programme is that it's on a much smaller scale… it really suits them better."

"Child is on the spectrum and was very reluctant to participate or try anything… then when he was with the home visitor, he'd say, I'll do that, I'll try that."

"He would refuse to do it anywhere else, but with them he would… it really opened him up."

"Some parents… they are on the phone… they don't spend too much time with kids.

Structural barriers such as limited programme capacity and waiting lists further restrict access, with demand exceeding availability in some cases. In addition, families described the emotional impact of programme endings, particularly where strong relationships had been formed, highlighting the importance of continuity and transition pathways.

"There was quite a long waiting list… we were waiting and waiting, but we were so excited when we got a place."

"You really develop a relationship with the home visitor… it's actually really sad when the programme finishes."

Parents' Prior Knowledge and Experiences of STEM

One theme we were interested in understanding more about was parents' prior knowledge and experiences of STEM and how that impacted their participation. Parents across the interviews consistently described having a limited or unclear understanding of STEM prior to participating in the programme, often associating it narrowly with school subjects or technical activities for older children. For example, one parent noted they "didn't understand what STEM was" and thought it referred to "machines or mechanical things," while another admitted they would have had "no idea" and even misinterpreted the term entirely. Even when parents recognised the acronym, their understanding was typically confined to formal education contexts, "science, technology and maths" without recognising everyday, play-based activities as part of STEM. This limited understanding appears to function as both a barrier and a neutral starting point for engagement. On one hand, it may prevent some parents from initially seeking out STEM opportunities, as the concept feels abstract, academic, or not relevant to young children. On the other hand, the findings suggest that parents were not deterred once trusted referral pathways were in place (e.g. through PC+, home visitors, or community networks), indicating that lack of knowledge did not prevent participation when access was facilitated and framed appropriately. In fact, this knowledge gap became a key motivator for continued engagement, as parents valued learning alongside their children and gaining practical strategies from trained practitioners. The shift from seeing STEM as a formal subject to recognising it in everyday interactions (e.g. nature exploration, play, questioning) also links strongly to other findings and, particularly improved parental confidence and changes in parent–child interaction. Overall, the data suggest that limited pre-existing knowledge of STEM is less a fixed barrier and more a latent opportunity, where programmes that demystify STEM and embed it in familiar, accessible contexts can drive both initial uptake and sustained participation.

"At the beginning I didn't understand what STEM was… I thought maybe it was about machines or mechanics, but I didn't know how it was relevant for kids."

"If I hadn't heard about STEM here, I would have no idea… I might think it was something to do with a steamer or cooking. I never heard about STEM growing up… it wasn't part of my childhood."

"Before the programme, I would have thought STEM was just science, technology and maths… I didn't realise things like planting flowers or exploring counted."

Conclusion

The findings indicate that participation in STEM programmes is most effectively supported through relationship-centred, accessible, and developmentally appropriate approaches. Across all cases, engagement is driven less by the concept of STEM itself and more by trusted relationships with ELI staff and established programme pathways. Families typically enter and remain involved through personal connections such as home visitors, school links, or word-of-mouth recommendations rather than formal promotion or subject interest. As a result, engagement often evolves organically over time, with participation becoming embedded within family routines and extending across siblings.

A key enabling factor is the provision of clear progression pathways, where families move from early interventions (e.g. ParentChild+) into follow-on programmes such as STEM Play and Learn, family events, or coding activities. These pathways sustain relationships while supporting children's developmental needs at different stages. Parents particularly value the role of STEM activities in fostering confidence, curiosity, persistence, and early learning behaviours, including school readiness and problem-solving skills. Importantly, these developmental benefits are reinforced when learning is hands-on, play-based, and easily transferable to the home environment, enabling parents to continue activities independently.

At the same time, the findings highlight persistent structural and systemic barriers that constrain access. Time pressures, competing family responsibilities, and logistical challenges remain significant, particularly for families with multiple children. Language and communication barriers also impact participation, limiting both awareness of programmes and confidence in engaging, unless mitigated through bilingual staff or culturally responsive supports. Related to this, low awareness and reliance on word-of-mouth communication suggest that existing outreach mechanisms may not fully reach more isolated or marginalised families.

Programme design also plays a critical role in inclusion. While larger, open-access STEM events increase visibility, they may inadvertently exclude younger children or those with additional needs, who benefit more from small-group, relationship-based delivery and familiar facilitators. Evidence from the case studies shows that children who were initially reluctant to engage particularly those with additional or sensory needs participated more fully in structured, trusted environments, highlighting the importance of consistency and relational support in enabling inclusion.

Finally, capacity constraints such as limited places and waiting lists restrict access for some families, reinforcing the gap between demand and availability. In addition, the emotional impact of programme endings particularly where strong relationships have been formed underscores the importance of continuity, transition planning, and sustained engagement opportunities beyond initial programme completion.

Overall, the data suggest that participation in STEM is not primarily an issue of interest or understanding, but of access, relationships, and delivery design. These patterns are consistent with the concept of low science capital (Archer et al., 2015), where limited exposure to science, low confidence, and narrow understandings of STEM influence how families engage with science-related learning. In this light, parents' initial uncertainty reflects broader structural inequalities in access to science knowledge and experiences, rather than a lack of motivation. The programme's success in reframing STEM as part of everyday life demonstrates how targeted supports can help build science capital by increasing confidence, recognition, and engagement in informal learning contexts.

Limited prior knowledge of STEM does not prevent engagement when programmes are framed in accessible, everyday ways and introduced through trusted channels. Instead, this knowledge gap represents an opportunity: when effectively addressed, STEM programmes can simultaneously support children's development, parental confidence, and sustained family engagement in learning where participation becomes embedded as a family norm.

9. Discussion

The findings from programme evaluation and the two research projects present a coherent and reinforcing narrative: STEM engagement in disadvantaged communities is shaped less by ability or interest, and more by confidence, relationships, access, and sustained exposure over time.

Across all programmes, very high levels of enjoyment, engagement, and perceived value indicate that when STEM is delivered in an accessible, hands-on, and family-centred way, it is both meaningful and appealing to children and parents. However, the deeper significance of these results lies in the mechanisms of change observed:

- **Parental confidence is a critical driver of engagement**
  Increased parental confidence (consistently reported across programmes) is not simply an outcome but a key pathway through which children's engagement, learning, and aspirations are strengthened.
  Parents move from uncertainty and avoidance to active participation, enabling richer home learning environments, becoming role models for children, and seeing the benefits of co-learning.

- **Children act as catalysts for family learning**
  Findings from interviews show that children's curiosity and enthusiasm often initiate parental engagement, highlighting a bidirectional relationship between parent and child learning.

- **STEM becomes normalised as part of everyday life**
  A major shift occurs when families begin to see STEM not as a formal subject, but as something embedded in everyday activities (e.g., play, nature, problem-solving).

- **Sustained exposure across programmes strengthens impact**
  Participation across multiple programmes (events, home visiting, coding) builds cumulative effects over time, increasing confidence, competence, and aspirations creating longitudinal impact and pathways. Gains are not just short term but sustained across childhood.

Importantly, the impact of the STEM Family Learning model is cumulative and developmental. Participation across multiple programmes and over extended periods contributes to a gradual building of confidence, competence, and familiarity with STEM. This reflects a longitudinal process, where early exposure through play-based and home-supported learning creates a foundation that is reinforced through later engagement in coding and structured activities. In this way, the model supports not only immediate outcomes but also longer-term educational trajectories, contributing to children’s aspirations and expectations for further and higher education. This sustained engagement aligns with science capital theory, whereby repeated exposure, increased confidence, and meaningful connections to everyday life contribute to a growing sense that STEM is accessible and “for me.”

These findings also need to be understood within a rapidly changing societal context, where digital technologies and artificial intelligence are reshaping education, employment, and everyday life. Parents’ mixed attitudes towards technology and AI, characterised by both optimism and concern, highlight the need for programmes that support not only technical skills but also confidence, critical thinking, and informed decision-making. The shift towards a STEAM approach within ELI’s work reflects this context, recognising the importance of creativity, problem-solving, and human-centred skills alongside technical competence. Supporting families to engage confidently with these changes is therefore an essential component of inclusive STEM education.

10. Comparison with Research and Literature

The findings strongly align with and extend existing literature on STEM education, parental influence, and informal learning.

Parental influence and self-efficacy

Consistent with the parental socialisation model and broader research, this study confirms that parents' beliefs and confidence directly shape children's engagement and outcomes. Parents with lower confidence initially avoid STEM, while increased confidence through programmes leads to greater involvement.

This reflects literature showing:

- Parental attitudes predict children's STEM achievement and motivation (Sonnenschein & Dowling, 2017; Šimunović & Babarović, 2020)
- Self-efficacy is a key determinant of engagement (Bandura, 1997)

Importance of informal and play-based STEM

The findings strongly support evidence that informal, play-based learning is central to early STEM development. Parents' shift toward recognising STEM in everyday contexts directly mirrors research on guided play and home-based learning environments.

Science capital and inclusion

The results align with science capital theory (Archer et al. 2015, 2023), demonstrating that STEM engagement is shaped by:

- Exposure
- Confidence
- Cultural relevance

The programmes effectively increase family-level science capital, especially among groups typically underrepresented in STEM.

Barriers in disadvantaged communities

Consistent with research on equity in STEM education, barriers identified include:

- Low parental confidence
- Limited awareness of opportunities
- Structural constraints (time, access, language)

However, this study contributes new insight by showing that:

- These barriers are highly responsive to intervention
- Relational approaches (trust, home visiting) can overcome them

Digital engagement and ambivalence

The findings on digital technology (simultaneous recognition of benefits and concerns) closely match existing literature on parental ambivalence toward technology, reinforcing the need for balanced, guided engagement.

11. What Worked Well

Across programmes and research strands, several elements emerged as consistently effective:

1. Relationship-centred delivery

Trust in ELI staff is the strongest driver of participation. Families engage because of relationships, not because of STEM as a subject.

2. Parent as co-learner model

Positioning parents as partners rather than instructors:

- Reduces anxiety
- Builds confidence
- Supports sustained engagement

This model successfully reframes parents as the "first and best teacher."

3. Accessible, low-cost, home-based activities

Activities using everyday materials:

- Remove financial barriers
- Enable continuation at home
- Reinforce learning beyond sessions

4. Play-based and experiential learning

Hands-on, enjoyable activities:

- Drive high engagement and enjoyment
- Support both cognitive and social-emotional development

5. Continuity and progression pathways

The structured progression (home visiting → events → coding):

- Sustains engagement over time
- Builds skills developmentally
- Enhances long-term outcomes and aspirations

6. Community Action Research approach

The iterative CAR model allows:

- Continuous programme adaptation
- Responsiveness to family needs
- Integration of lived experience into programme design and delivery

12. What Needs Improvement

Despite strong outcomes, the findings highlight several areas for development:

1. Parental confidence gap remains

While many parents gain confidence, a significant minority:

- Still feel uncertain supporting STEM
- Need more practical guidance

Implication: Expand structured supports such as:

- STEM 101 sessions (happening in 2026-2027)
- Demonstration-based learning
- Take-home guidance

2. Awareness and outreach limitations

Many families only discover programmes through:

- Word-of-mouth
- Direct relationships

Implication:

- Strengthen outreach strategies
- Use community networks, schools, and multilingual communication
- Increase visibility beyond existing participants

3. Structural barriers to participation

Time pressures, logistics, and competing demands limit participation:

- Particularly for working parents and larger families

Implication:

- Increase flexibility (timing, formats)
- Expand local and home-based delivery

4. Inclusion and accessibility challenges

Language barriers and additional needs impact engagement:

- Some families require tailored supports

Implication:

- Continue expanding bilingual delivery
- Maintain small-group, relationship-based formats
- Strengthen inclusive programme design

5. Capacity constraints and unmet demand

Waiting lists and limited programme places restrict access.

Implication:

- Increase programme capacity
- Secure sustained funding
- Scale delivery while maintaining quality

6. Transition and continuity gaps

Families experience programme endings as disruptive.

Implication:

- Strengthen transition pathways
- Provide clear onward routes between programmes

7. Digital and AI confidence

Parents show:

- Positive attitudes
- But limited understanding and confidence

Implication:

- Expand parent-focused digital and AI supports
- Provide practical guidance on safe and meaningful use

13. The Future

Recent public discourse has increasingly focused on the role of artificial intelligence in automating routine and entry-level work. While technical competence remains important, research and labour market analysis point to the growing value of skills that technology cannot easily replicate, including creativity, critical thinking, collaboration, empathy, and ethical reasoning. For families in the NIC, this rapidly changing landscape can feel distant, complex, and at times overwhelming. Findings from ELI's research suggest that while parents recognise the importance of STEM for their children's futures, attitudes toward digital technologies and AI are mixed, combining optimism about opportunity with concerns around screen time, social development, exclusion, and balance.

In response, the continued evolution of ELI's provision will align closely with its 2026–2030 STEAM Strategy, which emphasises the integration of creativity, inclusion, and emerging technologies into family and community learning. This reinforces the need for approaches that not only develop technical skills but also support families to engage critically, creatively, and confidently with technology. Building on existing provision, initiatives such as STEM 101 sessions for children and parents, "Think Like a Scientist" workshops, coding and STEM programmes in IPAS centres and temporary accommodation, and parent-focused technology and online safety clinics will expand access to meaningful, hands-on engagement. Central to this approach is a commitment to deepening parental involvement through flexible scheduling, multilingual delivery, and the ongoing demystification of STEM through play, storytelling, and everyday exploration.

While creativity and arts-based approaches have long been embedded within ELI's practice, the STEAM Strategy 2026–2030 makes this integration more explicit. Incorporating the Arts enhances engagement, inclusion, and meaning-making, enabling children and parent to think as creators, problem-solvers, and ethical citizens rather than passive users of technology. By foregrounding the 'A' in STEAM, future programming will encourage diverse ways of thinking, cultural relevance, and emotional engagement, while nurturing essential human capabilities such as curiosity, imagination, empathy, and ethical judgement—skills that are increasingly important in an AI-saturated world. Framed through a science capital lens, this approach aims not only to increase participation but to build families' confidence, knowledge, and capacity to engage with STEAM in sustained and meaningful ways, contributing to more equitable outcomes for children and communities.

14. Conclusion

Overall, the findings reinforce that participation in STEM is not constrained by ability, but by access, confidence, and opportunity. By addressing these barriers through a family-centred, community-embedded approach, ELI's STEM Family Learning model supports children and parents to establish and nurture their Science Capital to develop confidence, capability, and a sense of belonging in STEM. Crucially, this impact extends beyond individual participants, generating broader benefits across families and communities and contributing to more inclusive and equitable pathways into STEM education and careers.

The findings demonstrate that effective STEM engagement, one that builds Science Capital, confidence, curiosity and competence – that feeling of 'STEM is for me' or 'Doing STEM is the norm in our family' in disadvantaged communities requires more than simply access to content.

It depends on:

- Confidence-building (particularly for parents)
- Relational trust and sustained engagement
- Accessible, everyday learning approaches
- Clear developmental pathways over time

The ELI STEM Family Learning model is effective because it addresses these factors simultaneously, creating a family-centred ecosystem of learning rather than isolated interventions.

Importantly, the research shows that barriers to STEM are not fixed deficits, but modifiable conditions that can be addressed through thoughtful, inclusive programme design. As such, the model offers a scalable and evidence-informed approach for advancing inclusive STEM engagement, demonstrating how sustained investment in families, relationships, and accessible learning can support long-term change.

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16. Appendices

Parental Attitudes to STEM and Digital Technology

- Consent Form
- Follow Up Form
- Information Form
- Interview Questions
- Survey Questionnaire

Case Study

- Consent Form
- Semi Structured Interview Questions

Programme Evaluation forms

- Parent examples
- Child examples
- Kahoot Quiz