Irish National Teachers' Organisation
Cumann Múinteoirí Éireann

INTO Submission

to the Department of Education

Consultation on Phase 2 of the STEM Education Implementation Plan

26 January 2022

Introduction

The foundations for Science, Technology, Engineering and Mathematics (STEM) education begin in early childhood. From the earliest years through their play experiences and family environment, children engage with the world in ways that can promote learning related to Science, Technology, Engineering and Mathematics. Young children naturally engage in early STEM exploration through hands-on multisensory and creative experiences. By engaging in these experiences, children are developing curiosity, inquisitiveness, critical-thinking and problem-solving capacities which are built on through their primary and post-primary school education.

The Department of Education's STEM Education Policy Statement (2017–2026) provides a national focus on STEM education in our early years settings and schools and identifies the goals and actions required to achieve and improve the STEM education experience and outcomes for all learners. It sets out an ambitious journey up to 2026 which will be dynamic and evolve to meet the challenges of the future with a vision to provide "*the highest quality STEM education experience for learners that nurtures curiosity, inquiry, problem-solving, creativity, ethical behaviour, confidence and persistence, along with the excitement of collaborative innovation*". The INTO welcomes this opportunity to contribute to the consultation and outline key considerations for the Department of Education in devising an implementation plan for the coming years that builds on reforms and initiatives already underway in STEM.

Such is the rapid pace of change and technological developments; it is predicted that more than 60% of children attending school today will work in a career that does not currently exist (OECD, 2019). Science, Technology, Engineering and Mathematics (STEM) are key enablers for the Irish economy and for the development of important skills and competencies in our young people.

Outcomes of the Trends in Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) provided some benchmarks against which to gauge our STEM education outcomes. The TIMSS 2015 study stated that at fourth class in primary level, Irish students ranked 2nd in Mathematics out of the 22 participating European Union (EU) member states/territories and 9th out of all 49 countries participating. Irish students ranked 10th in science out of the 22 EU participating member states/territories and 19th out of all 47 countries.

In an Irish context, at primary level, the curriculum strives to promote the holistic development of the child, with its focus on the development of learners' skills, knowledge, and dispositions in an integrated, cross-curricular way. Children are naturally curious, therefore science in the primary school context should nurture this curiosity and allow them to ask questions and develop the skills they need to find an answer. Primary school science encompasses the content strands of Living Things, Energy and Forces, Materials, and Environmental Awareness and Care, and specifically supports the development of skills related to 'designing and making' and 'working scientifically'. These include questioning, observing, predicting, investigating, and experimenting, estimating and measuring, analysing, recording and communicating.

The Inspectorate's evaluation of the implementation of the first phase of the STEM Education Policy Statement 2017-2026 in a sample of Early Learning and Care (ELC) settings, and primary and post-primary schools during the period January 2019 to December 2019 provides some interesting insights into how STEM education policy is being implemented at school and early learning and care setting level.

The Inspectorate's report provides a benchmark for the education system and policy makers and will be helpful in informing actions that may need to be taken to ensure that national STEM education objectives can be achieved.

Learners' engagement with Science, Technology, Engineering and Mathematics (STEM)

Overall, where learner engagement and achievement in STEM is most effective at primary level, pupils are enabled to explore, investigate and to create using thematic or cross-curricular approaches that encompass a variety of subjects, activities, and approaches. This was evident in the findings of the STEM report 2020 which found that schools were very aware of the importance of STEM education and there was often a clear articulation by schools of the importance, value, and opportunities that STEM education holds for students. Whilst this was particularly prevalent at post-primary level, INTO welcomes the finding that 88% of primary schools visited were deemed to be 'very aware' of the national STEM education agenda.

Teachers' engagement with STEM education methodologies

Findings of this research in relation to teachers' and practitioners' engagement with, and use of STEM pedagogies in the 2020 report were positive, with more than four out of every five STEM lessons at primary level (and at post-primary level) deemed to be 'satisfactory' or better. Where high-quality STEM teaching was observed at primary level, it was often characterised by children's agency in their own learning, their use of the environment to engage in exploratory activity and opportunities to experiment with natural and other materials. The INTO welcomes members' high level of engagement with STEM education methodologies, acknowledging the central role of the teacher in cultivating an interest among children. The report illustrated that where STEM education was effective, teachers maximised the potential for children to develop their sense of wonder and natural curiosity and the INTO reiterates the importance of pupil voice in adopting a child-centred approach.

Of the primary schools visited as part of the 2020 review, 70% were found to have a whole-school planning or school self-evaluation (SSE) process that was impacting positively on STEM provision in the school. This indicates that whilst many schools are engaging well in this regard, there is scope in other schools to strengthen whole-school approaches.

The report identifies a challenge for schools in applying the School Self-Evaluation process to STEM in finding a common thread which has relevance across all curricular areas and can be implemented in a whole-school context. A suggestion within the report is that schools could focus on the cross-curricular development of critical thinking skills. Pupils' ability to reason, question and analyse is central to encouraging them to become 'critical thinkers,' promoting active learning rather than passive absorption of information. These skills are fundamental to learners' capacities to create, innovate and solve STEM-based problems and align to the competencies within the Draft Primary Curriculum Framework (2020).

At system level, significant work in STEM education is underway in areas such as curriculum and assessment reform, teacher professional development and the embedding of digital technologies in all classroom activities. In addition to these developments, the INTO identifies other key issues that must be addressed to ensure that the STEM Education Policy Statement can realise its ambition and that "*Teachers and early learning and care practitioners can engage with professional learning opportunities and embed STEM into their teaching practice to include the use of digital technologies.*"

Class size

Large classes at primary level are a barrier to the successful implementation of any curriculum subject. The nature of STEM teaching and learning is such that it demands discovery-based learning and inquiry-based, constructivist pedagogies which value philosophical inquiry with children. A reduced pupil–teacher ratio is a prerequisite to such active pedagogies and the INTO has long since advocated smaller class sizes to align with the European average.

While it is acknowledged that the staffing schedule for primary schools was reduced by one pupil per mainstream teacher last September and that a further similar reduction is budgeted for September 2022, the fact remains that the staffing schedule will operate on the basis of a general average of one classroom teacher for every 24 pupils from September 2022 and that Ireland's primary school classes will still be the largest in the EU at four pupils per class above the EU average.

Therefore, in order to pave the way for the successful implementation of the STEM Education Policy Statement 2017-2026, the INTO submits that as a minimum, the primary school staffing schedule must be reduced by one pupil per mainstream teacher each September up to and including September 2026 and that these annual reductions must be applied in all primary schools including DEIS schools.

Smaller numbers of pupils would help to facilitate a more active and, in junior classes, a more play-based approach to teaching and learning which enhance the development of pupils' capacity to be 'effective contributors' within the learning experience.

Funding for schools

There is a need to support schools and settings in the reimagining of creative spaces where STEM education methodologies and STEM based learning can thrive. Creative spaces should be identified in all schools and settings and resourced accordingly.

For effective learning environments to be created, increased investment in primary education is essential. UN Sustainable Development Goal 4.A commits to "*build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.*"

The Department of Education must ensure that all school facilities are equipped with the necessary teaching materials and physical space to allow pupils engage in effective, active learning. Investment in support material for teachers and adequate resources for schools is essential to ensure that teachers can meet curriculum objectives and effectively teach STEM subjects.

Continuous Professional Development

It is imperative that teachers and practitioners are provided with the training and Continuous Professional Development (CPD) to upskill in the ever-evolving area of STEM education. The STEM report 2020 states that Initial Teacher Education courses should review their programmes to ensure that they reflect and incorporate the associated pedagogies that are applicable to the STEM education experience. INTO reiterates the need to ensure that student teachers are afforded adequate training in this area followed by regular, appropriate CPD throughout their careers in line with advances in technology.

Pedagogy is key to transforming learning environment. Teachers play a pivotal role in enabling and progressing children's learning and their pedagogical strategies are the ways in which they tailor learning experiences. INTO advocates pedagogical strategies that include active learning, hands on learning and play, project-based learning and learning in the outdoors. Such approaches not only benefit the learning experience but can positively impact on assessment strategies.

During previous consultation with members on curriculum reform and development, feedback from teachers and school leaders consistently emphasised how essential the provision of ongoing professional learning is in supporting teachers in negotiating and realising curriculum developments. The approaches to CPD are important. Teachers would benefit from STEM supports being offered across the continuum of teacher professional development from initial teacher education to the

activities of other bodies such as the Teaching Council, the Professional Development Support for Teachers (PDST) and Education Centres.

The INTO recommend that CPD for STEM should be planned for and provided on a continual and well-resourced basis and should focus on a whole-school approach that supports a school's local context, environment and interests.

Posts of responsibility

The moratorium on promotion resulted in middle management structures in many schools being dismantled and, in some schools, this resulted in the absence of a STEM Co-ordinator who may previously have been assigned the role of leading the integration of Science, Technology, Engineering and Maths skills into teaching and learning at school as part of their post of responsibility.

Since 2018, there has been some flexibility in this regard. The full restoration of middle-management roles would afford schools the opportunity to delegate STEM-related preparation for teaching and learning (including the organisation of whole-school projects and activities) to members of the teaching staff. INTO reiterate the need to ensure that all teachers receive professional development in STEM across the course of their career to meet the evolution of science and technology and the emergence of new strategies. However, it is important to stress that any teacher who assumes a specific role as 'STEM Co-ordinator' within their school would have access to appropriate specific CPD in this area.

A school's STEM policy should be reviewed and reflected upon cyclically and adjusted according to the needs of the school community ensuring that enriched learning experiences are provided through a blend of exclusive and targeted STEM activities tailored to suit the needs of pupils and teachers. Whilst teachers with middle-management roles may be involved in such a review, it is important that all members of teaching staff would have the opportunity to engage in collaboration and open dialogue to discuss the teaching and learning of STEM.

Integration and creative learning spaces

In early learning settings, the report found that children are exposed to STEM education not only in what they learn, but more importantly how they learn and that this approach could be further embedded at primary (and post-primary) level where the compartmentalisation of subjects is more prevalent. Whilst the report promotes integrated experiences of STEM education to enhances pupils' learning experience, the challenge that this poses in scheduling classes and developing thematic and cross-curricular approaches to curriculum delivery is recognised.

A common thread running through examples of best practice shared in the STEM report is the facilitating of tasks and engaging learning activities which offered opportunities for discovery, inquiry, and exploration. The challenge for educators is to nurture these skills which are naturally occurring and abundant in children and young people, resisting the urge to focus on content at the expense of skill development. The Draft Primary Curriculum Framework seeks to support a more integrated approach to teaching and learning.

Outdoor learning

Outdoor learning provides children with an opportunity to experience the interdisciplinary nature of the real world through interactions with each other and the planet. Geographical enquiry involves exploring the outdoors in an investigative capacity, although sustainability is applicable to all curricular areas.

Among the '*skills and concepts'* within the current curriculum, is 'a sense of place and space.' The child's sense of place refers to his/her understanding of, and feeling for, the essential character of various places; an understanding of how landscapes have been formed and shaped by the interaction of natural processes and human activity, and an appreciation of the distinctive contribution made by the motivations, beliefs, values, and attitudes of people.

The value of exploration of the natural world and pupils' environment is reiterated in the National Council for Curriculum and Assessment (NCCA) Draft Primary Curriculum Framework (2020). Children's learning is shaped and nurtured by the physical environment, both indoors and outdoors. Diverse environments encourage children's independence and stimulate and support their learning across the curriculum. (NCCA, 2020). Concerns about children's current and future relationships with the environment have been highlighted with Louv (2010) warning of 'nature-deficit disorder' describing the human cost of alienation from nature, including physical and emotional illness, reduced use of the senses and attention difficulties.

Links with the community

Strong links with local industries, educational institutions and community groups are effective in enriching STEM education at school level. The report noted that there was evidence in the primary context, that such links impacted positively on teaching and learning experiences for pupils.

Opportunities for schools to support community efforts in advancing local projects across early childhood, primary and post-primary curricula should be promoted. Providing opportunities for initiative-taking and outreach from school to community and vice-versa would encourage greater connection and collaboration. School and community initiatives can be a powerful driver for change, anchoring STEM education in the real-world and lived experiences of pupils, enabling all involved to experience the benefits of working together co-operatively and supporting a sense of community cohesion towards a shared objective.

INTO is currently undertaking research on transitions from pre-school to primary school and the broad curricular area of STEM offers an opportunity for both settings to work collaboratively and co-operatively to enhance the STEM education experiences of learners, pooling resources to maximise teaching and learning. Some examples of such practice were outlined in the STEM report 2020.

Gender equity

Unfortunately, gender parity remains a challenge, particularly in the context of uptake of technology-based STEM subjects at post-primary level. Issues around gender stereotyping, curriculum accessibility and resourcing are all contributory factors to Ireland's high gender differential between male and female STEM graduates. The engagement of children and the creation of stimulating spaces for their engagement is crucial to promoting an interest in STEM areas among all pupils from an early stage. Gender-responsive STEM education is an approach to teaching and learning with the transformative potential to deliver on the promise of the girls' education and empowerment agenda in the 21st century. By learning science, mathematics, technology, and engineering solutions in an integrated manner to solve real-world problems and to challenge gender inequality, children and young people improve their understanding of how things work and improve gender-equitable use of digital technologies. Girls can become equipped with scientific and technical knowledge and skills that they can apply to real-life contexts in ways that strengthen their agency and enable them to critically understand social and environmental issues in the world around them.

Pupil voice

It is an underlying principle of the curriculum that the child should be an active agent in his or her own learning. The structure and content of the curriculum are designed to provide opportunities for active engagement in a wide range of learning experiences and to encourage children to respond in a variety of ways. The NCCA Draft Primary Curriculum Framework (2020) seeks to strengthen pupils' agency in terms of voice, participation, and decision-making.

The Children's School Lives longitudinal study involving 4,000 children as they progress from preschool through primary (and on to post-primary school) will inform the redevelopment of the primary curriculum, ensuring pupil voice will be an important dimension in reviewing STEM policy.

In preparing for teaching and learning in the broad curriculum area of STEM, teachers should consider pupils' interest and prior knowledge. Children should be enabled to critically understand social and environmental issues in the world around them, actively participate in debates to solve such problems, and propose relevant solutions.

Artificial Intelligence (AI) skills

Information and communication technology has brought profound changes to all aspects of our lives in recent years as its rate of change has accelerated. Digital literacy - the ability to access, critically evaluate and communicate effectively using digital media and ICT (Information and Communications Technology) - has become increasingly important. The European Commission considers it paramount that children learn about AI from an early age. This implies that schools must deliver a sound grounding in digital skills across the board. So-called 'soft' skills, such as critical thinking, creative thinking and data analysis are considered as extremely important for anyone wishing to work with AI during their career. The broad curricular area of STEM is conducive to the development of AI skills providing a relevant context that can foster pupils' curiosity.

The use of assistive technology has contributed to a transformation of the learning experiences of children with special educational needs (SEN). Advances in technology have led to the development of more sophisticated devices and equipment that can be used to improve the functional capability of a pupil with special education needs. Funding is provided to schools by the Department of Education towards the purchase of equipment for pupils with physical or communicative needs who have been assessed as having a special educational need that requires specialist equipment to access the curriculum. This pupil-specific scheme reflected the child-centred nature of the curriculum and seeks to allow pupils with SEN an alternative way to access teaching and learning. INTO believes that in an increasingly digitised world, enhanced access to assistive technology for pupils with special educational needs is paramount to support inclusion.

In conclusion

STEM subjects are relevant in our everyday lives, thus accentuating the need to ensure that effective education in this area from outset in early years education. In recent times of crisis young people demonstrated their STEM knowledge and skills to provide assistance in their communities. In some post-primary schools across the country, students answered the call of frontline workers to produce much-needed PPE. This work shows that an integrated approach to science, technology, engineering, and mathematics can have a positive impact on our lives, exemplifying how these disciplines can co-exist and interact effectively to realise a design solution for the good of society overall.

As the world we live in continues to swiftly change and advance, we will be confronted with numerous other challenges and unknowns. It is vital that we equip our young learners with the STEM tools that will enable them to tackle these obstacles in a problem-solving, solution-focused approach.

Teachers are committed to providing the best possible outcomes for their pupils, both now and in the future. To cultivate an enriching learning environment, teachers need relevant curricula and tools for their pupils to reflect and acquire knowledge on how they can make a difference for the future. To achieve this, appropriate resources and funding are vital. The INTO calls for increased investment by government to ensure that all teachers in our primary schools are provided with appropriate professional development and supports to realise the ambitions within Ireland's National STEM Policy.

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