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Iúil 2023

Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

The Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

July 2023

33/ES/16

MEMBERSHIP

 Sorca Clarke TD Sinn Féin	 Cathal Crowe TD Fianna Fáil	 Mairéad Farrell TD Sinn Féin
 Paul Kehoe TD Fine Gael (Cathaoirleach)	 Carol Nolan TD Independent	 Jim O’Callaghan TD Fianna Fáil
 Marc Ó Cathasaigh TD Green Party	 Pádraig O’Sullivan TD Fianna Fáil	 Aodhán Ó Ríordáin TD Labour Party

 Senator Aisling Dolan Fine Gael	 Senator Eileen Flynn Independent	 Senator Rónán Mullen Independent
 Senator Fiona O'Loughlin Fianna Fáil (Leas-Cathaoirleach)	 Senator Pauline O'Reilly Green Party	

CATHAOIRLEACH'S FOREWORD

The Joint Committee on Education, Further and Higher Education, Research, Innovation and Science identified the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education as a key priority issue.

The Joint Committee agreed to produce a report having identified the following key Modules:

- STEM in Primary Education.
- STEM in Post-Primary Education.
- STEM in Tertiary Education.
- Female Participation, Diversity and Inclusion in STEM.
- Digital Strategy in Education to Support STEM.

The Committee sought and received written submissions from a wide range of stakeholders. The quality of the evidence based on comprehensive research findings and the knowledge and insights provided were of tremendous assistance in preparing this report. The submissions are contained at Appendix 1 as valuable reference material.

The Committee met with key stakeholders including relevant unions; school management bodies; key statutory and representative bodies; other relevant organisations and, most importantly, we heard the voices of young people themselves. Mr Shane O'Connor and Mr Liam Carew, 2023 Young Scientists of the Year and Worldskills Award Winners Mr Jamie Bermingham, Plumbing Apprentice and Mr Martin Scattergood, Sheet Metal Work Apprentice, assisted the Committee greatly by sharing their perspectives and experiences.

The Joint Committee also met with a panel of distinguished academic experts who provided excellent guidance and support to the Committee. I would like to thank Dr Margaret Leahy, Head of the School of STEM Education, Innovation & Global Studies and Professor Hamsa Venkat, Professor of STEM Education for Primary and

Early Childhood Education, both from the Institute of Education, Dublin City University (DCU), who steered the Committee in the right direction at the outset.

Senior Officials from the Departments of Education and Further and Higher Education, Research, Innovation and Science, came before the Committee with key statutory bodies and provided very beneficial briefings on their plans for STEM.

Arising from this, the Committee examined the evidence heard and the submissions received and drew up this Report containing concrete and feasible recommendations. The Committee genuinely believes these can be implemented without delay and can provide a clear road map for the future of STEM in Irish Education.

The Irish education system should give students the confidence to enter the wider world with the life skills to progress to whatever path in life they choose to take. Ensuring students have full access to STEM subjects from Pre School and onwards will give them unrivalled opportunities as they face the future.

Once again here I reiterate that young people are our future. The future is uncharted territory given the enormous challenges we all face in terms of the Environment and Climate Change; Geo Political Threats; Digital Technology including Artificial Intelligence (AI) and so on. However, those with a willingness to embrace STEM as an integral part of their learning journey will have enormous opportunities to make meaningful contributions to our country and on the international stage too.

All students must be given equal access to these opportunities. Diversity and difference should be respected and, indeed, celebrated in Irish Education. All barriers must be broken down and all students must be given the resources they need to engage in STEM.

The Committee is committed to ensuring these recommendations are implemented as expeditiously as possible.

On 12 July 2023, the report was agreed to be published by the Committee.

The Joint Committee also requests that the issues raised in this report be the subject of a debate in both Houses of the Oireachtas.

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Paul Kehoe T.D.,

Cathaoirleach,

Joint Committee on Education, Further and Higher Education, Research, Innovation and Science.

12 July 2023

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EXECUTIVE SUMMARY

There was a consensus among all the stakeholders that early childhood is the ideal time to introduce STEM concepts as young children are naturally curious and inquisitive. Introducing STEM at this age does require a structured pedagogical approach. To this end, Early Childhood Education should be the responsibility of the Minister for Education.

It was also universally agreed that teachers must have knowledge and enthusiasm for STEM subjects if they are to teach them with confidence. Therefore, a Mandatory Module on integrated STEM Education should be provided in all Initial Teacher Education (ITE) courses, and to all Early Years Education, Primary Teachers as part of their Continuous Professional Development (CPD).

The National Children's Science Centre, in gestation for many years, should be opened as a matter of urgent national priority. It will send out a message that Ireland is very serious about science education for Primary and Post Primary students.

The Department of Education should publish revised specifications for Physics, Chemistry and Biology at Senior Cycle by the end of 2023. A key priority should be that the revised syllabus for each subject is far more detailed with comprehensive instructions for teachers.

Recruitment and Retention of qualified teachers emerged throughout the examination as a matter of critical concern. An *Expert Working Group on Teacher Supply for STEM Subjects and Computer Science* should be established by the Department of Education.

Evidence shows that talented and gifted students are not supported enough. The Department of Education should develop a *National Programme for High Performing Students*[1] in Primary in and Post Primary Schools to enable them to reach their full potential.

[1] High Performing Students should be identified primarily on the results of the Drumcondra Standardised Tests in English and Mathematics from Second Class and onward.

An *Expert Working Group on Pathways from Further Education to Higher Education* should be established to ensure that all citizens are given the opportunity to progress in their lives and fulfil their true potential.

Apprenticeships are now seen as gateways to exciting and fulfilling careers. Funding must be provided to the Technological Universities (TU)s to ensure there is sufficient physical capacity and lecturer capability to deliver on the increased numbers of Craft and New Generation Apprentices.

In a spirit of genuine partnership and joined up thinking an *Expert Working Group on STEM Subjects and Increased Female Participation* should be established by the Department of Education.

Digital learning has become fundamentally important in all our lives. The Department of Education should publish an Implementation Plan so that the excellent Digital Strategy for Schools to 2027 becomes a reality.

The other recommendations in the report are also very important in terms of driving this agenda forward and really making a difference in creating a Whole STEM Culture throughout the Irish education system.

TEN KEY RECOMMENDATIONS

Below are the Ten Key Report Recommendations, listed by order in which they appear in the main body of the Report. They are of equal value.

1. Responsibility for all Early Years Education should be transferred from the Minister for Children, Equality, Disability, Integration and Youth to the Minister for Education to ensure, *inter alia,* that STEM education is an integral part of the Early Childhood Care and Education programme (ECCE).

2. A Mandatory Module on integrated STEM Education should be provided in all Initial Teacher Education (ITE) courses, and to all Early Years Education, Primary Teachers as part of their Continuous Professional Development (CPD) These models should be geared towards teaching and learning that supports inquiry, experimentation and higher-order thinking and skills in the STEM areas.

3. The National Children's Science Centre should receive the full support of Government with a view to an early launch in Q4 2023. Once opened, it is recommended:

- The Centre receives Ring Fenced Funding on a Multi Annual Basis from the Department of Education to ensure it is adequately resourced to fulfil its mandate.
- The Centre liaises with the Department of Education Inspectorate so that it can play a central role in supporting STEM in the Primary and Post Primary School Curriculum.
- The Department of Education issues a Circular to all Primary and Post Primary Principals with a view to ensuring students visit the Centre as part of the STEM Curriculum.

4. The Department of Education should publish revised specifications for Physics, Chemistry and Biology at Senior Cycle by the end of 2023. A key priority should be that the revised syllabus for each subject is far more detailed with comprehensive instructions for teachers. The Committee recommends that the National Council for Curriculum and Assessment (NCCA) reviews the proposed design of the new specifications to ensure teachers are properly supported and students are taught to the highest professional standards.

5. An *Expert Working Group on Teacher Supply for STEM Subjects and Computer Science* should be established by the Department of Education in Quarter 4, 2023. The Group should be chaired by an external expert and comprise teachers, the National Council for Curriculum and Assessment (NCCA), Relevant Teacher Training Institutions, Subject Matter Experts and senior officials from the Departments of Education and Further and Higher Education, Research, Innovation and Science.

6. The Department of Education should develop a *National Programme for High Performing Students*[2] in Primary and Post Primary Schools to enable them to reach their full potential. The Department should liaise with the Centre for Talented Youth (CTYI) in Ireland at Dublin City University (DCU) in this regard with a view to agreeing on a Service Level Agreement (SLA) that would include, *inter alia*, Training for Teachers in Programme Delivery. The Programme should be rolled out nationwide so that all relevant students have equal access to it.

7. An *Expert Working Group on Pathways from Further Education to Higher Education* should be established by the Minister for Further and Higher Education, Research, Innovation and Science. The Group should be chaired by an External Expert and be comprised of Senior Department and Higher Education Authority (HEA) Officials, the Irish Universities Association (IUA), the Union of Students in Ireland (USI), the Technological Higher Education Association (THEA), SOLAS, Industry Representatives and Staff Unions. The Group should identify current opportunities and barriers to progression from Further to Higher Education and establish how to develop links between both sectors that allow for more seamless progression.

[2] High Performing Students in Primary Schools should be identified on the results of the Drumcondra Standardised Tests in English and Mathematics from Second Class and onward.

8. The Higher Education Authority (HEA) should provide ring fenced funding to the Technological Universities (TU)s, as necessary, to ensure there is sufficient physical capacity and lecturer capability to deliver on the increased numbers of Craft and New Generation Apprentices. To this end:

- The Department of Further and Higher Education, Research, Innovation and Science Emergency should provide Short Term Funding to bridge the gap.
- From 2023, the Department should provide Multi Annual Funding through a new Apprenticeship Fund.
- The Higher Education Authority (HEA) should commence a Review of the Craft and New Generation Apprenticeship Building Requirements by Q3, 2022, with the aim of delivering the buildings required to ensure Apprentices are educated to the highest international standards within a 3-year period.

9. The Department of Further and Higher Education, Research, Innovation and Science Education should establish a Consolidated System for the compilation of disaggregate Data Collation and Measurement on the researchers to include gender, disability, ethnic minority and economic status. The data should also record the nature of individual research being undertaken and the proposed outcomes. This data should be used to inform the development of educational policy on an ongoing basis.

10. The Department of Education should publish an Action Plan to implement *the Digital Strategy for Schools to 2027* by Q4 2023.

INTRODUCTION

Globally, humanity faces rapid technological advancements and societal changes, along with uncertainty over the future of work, the economy, and society. STEM will play a critical role in all our futures and STEM education is vital in preparing students for the future and providing individuals with the skills and knowledge necessary to succeed in a wide range of careers and fields in the rapidly changing world. STEM jobs are more in demand every day and expected to grow exponentially over the next few years.

In its submission, the National Association of Principals and Deputy Principals (NAPD) referred to the United Nations Educational, Scientific and Cultural Organisation, UNESCO Paper published in 2019 *“Exploring STEM Competencies for the 21st Century*”. The paper contends that the core feature of STEM is the use of science, technical and engineering knowledge to solve daily or societal problems. It opines that this makes the learning of science, technology, engineering and mathematics more meaningful and contextual for students.

The NAPD also asserts that ‘*Humanities and STEM are indeed complementary and the skills learned are transferable to every other area of the students life. While problem solving, critical thinking and collaboration are critical for success, the most important attribute that will support the future development of STEM in Irish education is attitude*’. This assertion or variations of it is repeated in several other submissions.

In oral evidence, on 9 March 2023, Mr Paul Crone, Director, NAPD made insightful comments on the State examinations at post primary level- ‘*The reformed junior cycle prioritises skill development and the STEM skills that I outlined earlier are central to all aspects of the junior cycle. This prioritisation of skill development over knowledge retention is lost once the students enter senior cycle. The continued significance of the terminal exam and the selection procedures for higher education continue to impact on the curriculum at senior cycle.*

Senior cycle is currently out of line with the junior cycle and the primary curriculum. It is a matter of urgency that we expedite meaningful senior cycle reform to bring *coherence to our system and give students the freedom to explore the STEM skills of problem solving, critical thinking and collaborative learning. In addition, to further break down the barriers to participation in higher education, the development of pathways for every student must be pursued. Removing the cliff edge of the leaving certificate, creating adequate pathways for all and affording students the opportunities to pursue their passion are key. We must give students the opportunity to explore and pursue inquiry-based learning or phenomenon-based learning and give them time to discuss, reflect and grow in confidence and competence.'*

In its submission, the Higher Education Colleges Association (HECA) submission refers to National and international competency frameworks that broadly agree on the importance of 21st century skills, which are transferable knowledge and skills that learners need for STEM proficiency.

It reported that, in Ireland, STEM education is a key focus in various educational policies such as the Action Plan for Education, National Skills Strategy, Arts in Education Charter, National Strategy: Literacy and Numeracy for Learning and Life, Digital Strategy for Schools to 2027, and the STEM Education Policy Statement 2017-2026. The STEM Education Policy Statement identifies actions to be taken in initial teacher education (ITE), including improving the quality of ITE, developing guidelines for STEM education in school placement, and fostering partnerships between ITE, STEM research, and industry.

In oral evidence, on 25 April 2023, Ms Evelyn O'Connor, Principal Officer, Department of Education reported that '*The building and sustaining of a vibrant STEM and digital education ecosystem for all learners will require ongoing innovation in STEM and digital education underpinned by evidence.*
There are many areas where work is ongoing in order to further enhance STEM and digital learning within our schools. This work includes the development of a strategic framework for lifelong guidance, a comprehensive programme of work to support teacher supply with a number of measures being progressed, the development and implementation of recommendations in relation to gender balance in STEM and primary and senior cycle redevelopment. The Department will continue its work with

colleagues in other Departments and with the wider education stakeholders, in order to provide a high-quality STEM education experience for all our learners that creates a positive disposition towards STEM and digital learning, and enables them to participate, influence and succeed in a changing world.'

In oral evidence, on 25 April, Ms. Karen Murtagh, Assistant Principal Officer, Department of Education, made the fundamentally important point about the future of STEM '*In all of this, we cannot lose sight of this not just being about the world of work and pushing kids into STEM jobs. The skills they learn within STEM subjects in school are vital for everyday life such as problem solving and critical thinking. When the committee is considering this, it may consider STEM skills are needed for all learners, no matter whether they progress to the world of work within a STEM career.'*

CHAPTER 1 – EARLY YEARS AND PRIMARY EDUCATION

EARLY CHILDHOOD EDUCATION AND CARE (ECEC)

In their submission, Professor Hamsa Venkat & Dr Margaret Leahy, Head of the School of STEM Education, Innovation & Global Studies and Professor Hamsa Venkat, Professor of STEM Education for Primary and Early Childhood Education, Institute of Education, Dublin City University (DCU) outlined how it is well recognised that important foundations for future learning, achievement and wellbeing are developed in the early years.

The submission further expanded on this by explaining that this is similarly the case for STEM Education. The submission pointed out that young children are naturally inquisitive, creative, and collaborative; these are innate dispositions which lend themselves well to STEM education.

Although an emergent area of focus in Early Childhood Education and Care (ECEC), STEM research and policy published in the last five years recommends the introduction of STEM education at an early age. This is perceived as important for the development of the foundations of skills, knowledge, beliefs, confidence and self-efficacy in STEM. It is also important as STEM achievement gaps are known to begin in the early years and will persist if unaddressed.

The submission evidentially noted that the empirical research base indicates that STEM provision in ECEC is linked with significantly higher enthusiasm and motivation for science in later life and is predictive of later academic achievement in mathematics knowledge and skills. It explains that the introduction of engineering provides a cross-disciplinary foundation that contextualises young children's mathematics, science, and technology learning, and supports meta-cognition.

Despite this, the submission noted that evidence indicates that STEM in ECEC is often of poor quality. Educators report that their initial education does not prepare them to support STEM in ECEC.

The submission refers to negative beliefs about STEM and poor self-efficacy that impacts on STEM practices in ECEC settings. Discipline content knowledge is also weak as that STEM is not a required subject in ECEC initial education.

The submission proposes adapting a play-based approach to STEM Education as this is seen as particularly beneficial in the early years. It also advises that proficiency in the fundamentals of each discipline is the first step toward competent integrated STEM education in ECEC.

In oral evidence, on 18 April 2023, Dr Sarah McCormack, Professor in Environmental Engineering, Trinity College Dublin, outlined the trajectory that often follows STEM '*Sometimes there is an idea, even going back to primary school, that certain students are not good at maths or science and they might pick biology because they think physics is too difficult. These are misconceptions some people hold but they might not know enough about physics to say whether it is too difficult. Breaking down those biases regarding the subjects is important. Likewise, in the case of computer science, the mention of algorithms is enough to turn some students off the subject. Explaining to them what an algorithm is and how they are used in everything we do today is important, and it is about getting in early to explain what these subjects are. We often see the unconscious bias stuff whereby people are waiting on the firefighter to come in. They are expecting men and it turns out to be women, and the little kids are so surprised because they have never seen a woman firefighter before. With these types of things, it is very important that we try to get in as early as possible so they understand the opportunity is there for everyone.*'

TEACHER TRAINING

In its submission, The National Parents Council (NPC) referred to an NPC National Parents Council Primary Survey on STEM Education in Primary and Post Primary Education. The survey found that the majority (79%) of parents reported that their child is interested in and excited about learning about STEM subjects in school. However, the most common response to what nurtures this excitement, were the child's own interest in and enjoyment of STEM subjects (68%). Only 21% of parents said that their child's teacher seems passionate about STEM subjects.

15% of parents felt that their child's teachers "*access to the materials and upskilling needed to teach STEM subjects*" supported their interest. Parents identified things like opportunities for "*designing & making things at school*" (66%) and "*being supported and encouraged to imagine, question, be curious and explore objects and ideas*" (53%) as things that would further support their child's STEM learning. 51% of parents said having a teacher who seems passionate about teaching STEM would support their child's engagement. 49% of parents felt that their child's teacher having access to the materials and upskilling needed to teach STEM would support their child's STEM education.

In its submission, the Irish National Teachers Organisation (INTO) stated that '*it is imperative that both practicing, and student teachers are provided with the training and Continuous Professional Development (CPD) to upskill in the ever-evolving area of STEM education. It recommended that CPD for STEM should be provided on a continual, planned and well-resourced basis, focussing on a whole-school approach which supports a school's local context, environment and interests.'*

In its submission, the Engineering and Technology Teachers Association (ETTA) opined that '*there is a need for an educational campaign with supporting CPD for primary teachers to provide in-depth and meaningful experience and resources to aid all the primary teachers of all aspects of STEM subjects, with specific emphasis on supporting the transition to post primary. It would be important to engage parents through a national information campaign on STEM subjects and the progression from primary to post primary and tertiary, while informing them of careers available and paths after the completion of tertiary education. The STEM area is ever changing and generally, without specific knowledge about an area of STEM, parents fall into using outdated, stereotypical outlooks on these areas, undoubtedly influencing their kids.'*

In oral evidence, on 21 March 2023, Mr Barry Convey, ETTA, made a compelling point about the prevailing culture regarding STEM capabilities '*I do think there is an issue about confidence among primary-school teachers but also about students' perceptions. When they get into second level, they already have this* *preconceived notion that STEM is difficult. We have to really look at where that is coming from. If I tell a taxi driver that I am a maths teacher, the response is “Oh God, I hate maths, I was useless at maths”. It is like a national pastime. We are delighted celebrating how bad we were at maths. Nobody would ever say “I cannot read, I find it difficult to read”. That is a huge shift in psychology that we need to make in this country. Maybe it is something we need to look at from primary school. We need to move away particularly from treating maths as a subject of being right and wrong, black and white. We need to promote the idea of students challenging themselves, trying and doing something instead of giving up just because they do not feel they can get all the way through to the final answer.’*

INTEGRATION AND RESOURCING OF STEM

In its submission, the Irish Primary Principals Network (IPPN) made a profound observation, that the biggest challenge to the promotion of STEM is the simplest one. If children – both girls and boys - are exposed to interesting, well thought-out, well-planned STEM lessons that build on their previous work, then they will be more interested in taking these subjects at second level. Research shows that, where interest is not developed by the end of primary, children do not take these subjects later.

It further stated that there is widespread agreement in primary education that, while STEM subjects are valuable, there should not be undue emphasis on them at the expense of other aspects of education, especially the Arts. It refers to other developed countries who have adapted STEM to include the arts, known as ‘STEAM’. It opined that there is an opportunity for the Department of Education and the NCCA to integrate the curricula to cover all of STEAM.

Referring to the new Primary Curriculum, it contended that there is an opportunity to further promote and develop the ‘softer skills’ – particularly communication and interpersonal skills - and pupils’ creativity within the curriculum, alongside enhanced STEM education. It further contended that these life skills are crucial to any organisation, including those in the technology industry.

The INTO Submission made an important point that '*Whilst the 2020 STEM report promotes integrated experiences of STEM education to enhance pupils' learning experience, the challenge that this poses curriculum delivery is recognised. The Draft Primary Curriculum Framework, recently approved by the Minister, seeks to support a more integrated approach to teaching and learning. The NCCA and other stakeholders must bear this in mind in the development of a coherent curriculum*.'

It opined that there is a need for an educational campaign with supporting Continuous Professional Development (CPD) for primary teachers to provide in-depth and meaningful experience and resources to aid all the primary teachers of all aspects of STEM subjects, with specific emphasis on supporting the transition to post primary. It referred to how important it is to engage parents through a national information campaign on STEM subjects and the progression from primary to post primary and tertiary, while informing them of careers available and paths after the completion of tertiary education.

In oral evidence, on 7 March 2023, Ms Máirín Ní Chéileachair, Assistant General Secretary, INTO, made an important observation '*We need to look at it on a much wider scale with engagement from a very young age, from early childhood at primary school. A number of years ago the Department of Education put in place some protocols with technology companies engaging with schools but it was at a very basic level. We need to look at that and to encourage all students to see women, be they snooker players or soccer players, in their jobs and we would not normally think about how STEM comes into jobs. I was privileged to engage in an NCCA consultation with children on STEM before Christmas and their perceptions were fascinating. They were very broad-minded in their concept of STEM.*'

Regarding investment, Ms Ní Chéileachair commented – ''*We said earlier that we would be hard-pressed to find a science lab in a primary school. We need to look at how we design learning spaces. We spoke earlier about creative multipurpose spaces, which are sadly lacking in our schools at primary level. We are very good at providing classroom accommodation and perhaps, if one is lucky, God save us, a halla. Aside from that, there are no flexible learning areas in our schools which can be used for creative learning, and for things that require movement and* *collaboration. Classrooms, to a certain extent, can be used for these purposes but there needs to be a look at creative indoor and outdoor spaces. I realise that I am repeating myself but it is very important that these flexible spaces are made available at a very basic level, even somewhere where infants and early learners can go to play and engage with sand, water and all of those things which develop early STEM skills, such as exploration, manipulation of materials, playing with concrete materials, using their hands and working together in teams. Sometimes traditional classroom spaces do not allow for that so we need to look at the development of creative spaces and outdoor learning space*.'

In its submission, the Institute of Physics (IOP) noted that a curriculum alone does not deliver change in the education system. Rather, it does so in conjunction with the empowerment of teachers and schools. It contends that without support and empowerment, most teachers opt for the elements of STEM that they are most confident in their own abilities to teach. With the common misconceptions about physics, it is the IOP belief that a lack of teacher support has/would result in physics being one of the more neglected STEM subjects.

In oral evidence, on 25 April 2023, Ms Arlene Forster, CEO, National Council for Curriculum and Assessment (NCCA) reported that '*Looking then at the future of STEM in Irish education, we have some great opportunities ahead of us. I mentioned the new primary mathematics curriculum in the opening statement. One of the important messages underpinning the overall philosophy of that curriculum is mathematics is for all and everybody can succeed in mathematics. That is a very important message. As to how that transacts in terms of teaching and learning, there is a strong emphasis on children being active in their mathematical learning, talking about their mathematical learning and talking aloud about how they are thinking and collaborating with each other. We know from literature that when you use that type of pedagogy, specifically that inquiry-based approach, in maths or in any aspect of science, it motivates and captures the interest of children. I hope an emphasis on that type of approach to STEM education will help us to motivate and encourage children and to ultimately work towards a more balanced approach when it comes to the gender take-up of STEM subjects as young people move into post-primary education.'*

In its submission, Technological University Dublin (TUD) cited multiple research studies that demonstrated children as young as age six endorse stereotypes that girls are less interested than boys in computer science and engineering (Master, Meltzoff & Cheryan, 2021) and believe that boys are better than girls in some STEM subjects such as programming (Master, Cheryan, Moscatelli & Meltzoff, 2017).

TUD proposed that the '*primary curriculum should be amended to foster an interest in STEM, primarily through the use of practical examples in the classroom. This should aim to foster the child's capacity to understand and engage fully with the world around them, with an emphasis on problem based learning using basic STEM principles. A simple toolbox of STEM activities could be deployed across primary schools. Consultation with stakeholders in the design of this would be important.'*

It also proposed that consideration should be given to gearing school tours towards fun STEM-related sites such as hi-tech manufacturing plants and data centres, Universities, and museums. It also made the insightful point that engagement with a gender-balanced selection of employees can serve as early role models for all children.

Other submissions, including personal testimonies from Worldskills Award winners and the 2023 Young Scientists of the Year, point towards the value of having STEM related Competitions and extra curricular activities to engender a sustained interest in these subjects.

Dr Áine Hyland, in her submission and in oral evidence given on 21 March 2023, outlined plans for a National Children's Science Centre, due to open shortly at the National Concert Hall Building, Earlsfort Terrace, Dublin 2. The centre will house three floors of immersive, interactive exhibits and a state-of the art Digital Planetarium with further capacity to host travelling exhibitions.

Dr Hyland made the pertinent point that this vital initiative aligns with the government's *STEM Education Policy Statement 2017-2026* which emphasises the need to nurture curiosity, inquiry, problem-solving, ethical behaviour, confidence and persistence, along with the excitement of collaborative innovation.'

It will also contribute to the implementation of the United Nations Sustainable Development Goals and will be a resource for teachers in the interpretation of and expansion of the Department of Education's STEM curriculum.

In its submission, the Irish National Teachers Organisation (INTO) recommended the full restoration of middle-management posts in primary schools to afford them the opportunity to delegate STEM-related preparation for teaching and learning (including the organisation of whole-school projects and activities) to an in-school management team member. The Teachers Union of Ireland (TUI) made a similar recommendation for Post Primary Schools.

The INTO submission also highlighted that outdoor learning provides children with an opportunity to experience the interdisciplinary nature of the real world through interactions with each other and the planet. It opined that 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). It recommended that sufficient investment must be provided to develop outdoor spaces in schools to facilitate the interdisciplinary nature of STEM.

In its submission, Airfield Estate proposed that STEM in Irish Education must incorporate food education, and that "hands-on" experiences should be built into this. It notes that this method of teaching has a huge positive effect on learning, and on igniting a passion for STEM subjects among students.

RECOMMENDATIONS: PRIMARY EDUCATION

1. Responsibility for all Early Years Education should be transferred from the Minister for Children, Equality, Disability, Integration and Youth to the Minister for Education to ensure, *inter alia,* that STEM education is an integral part of the Early Childhood Care and Education programme (ECCE).

2. ECCE Initial Teacher Education (ITE) must contain STEM modules to enable STEM Education to begin in early childhood, as supported by the Early Childhood Curriculum Framework, AISTEAR.

3. The Primary School curriculum must include:
    - A stipulated weekly time allocation for science as this has been under pressure in recent years.
    - A stipulated time per term for work involving integrated STEM projects across other subjects and across all primary grades.
    - Both practising and student teachers must be provided with exemplar support materials to build confidence and facilitate teaching Science in addition to a programme of initial and in-service teacher education focused on supporting integrated STEM.

4. A Mandatory Module on Integrated STEM Education should be provided in all Initial Teacher Education (ITE) courses, and to all Early Years Education, Primary Teachers as part of their Continuous Professional Development (CPD) These models should be geared towards teaching and learning that supports inquiry, experimentation and higher-order thinking and skills in the STEM areas.

5. Additional targeted teacher allocation should be given to schools so that small schools can provide STEM subjects with small classes and thereby equitably maintain student choice and equality of opportunity. This additional

teacher allocation could be provided by way of curricular concession. Curricular concession should also be provided where schools wish to provide new subjects such as Computer Science.

6. The Department of Education should restore middle management positions removed from schools and undertake an assessment of School Leadership posts at Primary level. This would afford them the opportunity to delegate STEM-related preparation for teaching and learning to an in-school management team member.

7. All new school builds and school upgrade programmes should include a STEM resource room(s) that can be used for project work (and could double up for use in other subjects) to support inquiry and experimentation.

8. Outdoor learning provides children with an opportunity to experience the value of exploring the natural world and their environment. Sufficient investment must be provided to develop outdoor spaces in schools, particularly those currently without access to such spaces, to facilitate the interdisciplinary nature of STEM.

9. The National Children's Science Centre should receive the full support of Government with a view to an early launch in Q4 2023. Once opened, it is recommended:

- The Centre receives Ring Fenced Funding on a Multi Annual Basis from the Department of Education to ensure it is adequately resourced to fulfil its mandate.
- The Centre liaises with the Department of Education Inspectorate so that it can play a central role in supporting STEM in the Primary and Post Primary School Curriculum.

- The Department of Education issues a Circular to all Primary and Post Primary Principals with a view to ensuring students visit the Centre as part of the STEM Curriculum.

CHAPTER 2 POST-PRIMARY EDUCATION

TEACHER RECRUITMENT AND RETENTION ISSUES

In its submission, The Irish Maths Teachers Association (IMTA) expressed concern about the serious shortage of qualified mathematics teachers in the state at present, despite initiatives such as the introduction of the Professional Diploma in Mathematics for Teaching (PDMT). It proposes offering financial incentives to encourage qualified graduates to become maths teachers. It also makes the point that teacher training places should be ringfenced for STEM teachers.

It further proposed that '*Consideration should be given to the length of time taken from entering college to qualifying as a teacher, especially in the situation in which student teachers are not paid. The state should foot the bill for prospective STEM teachers or offer them a full reimbursement of their fees after successfully working as a teacher in an Irish school after 5 years (or similar). We need to offer more supports to newly qualified teachers too and pay them a full 22-hour salary but increase their teaching load gradually over a number of years. NQTs should be mentored for a number of hours per week and encouraged to visit other schools and settings during time that they are not scheduled to teach. We need to nurture our NQTs; not scare them off.*'

Finally, it recommended that the Teaching Council (TC) review the requirements it specifies for accreditation of teachers. It contends that the present ones impose barriers that exclude good candidates.

In its submission, the Institute of Physics (IOP), identified, *inter alia*, how high-quality teaching from a *subject specialist* is one of the single most important factors in pupil experience, attainment and whether or not they pursue the subject post-16.

It noted that '*within the Irish system there are no physics-only teachers with a teacher often delivering a small number of different subjects. This reduces the chances of a teacher having a physics specialism and means their time for CPD has to be spread across all their subjects. Equally, the high demand for physics skills reduces the future teacher pool further. They will likely have more attractive* *alternative offers unless they have a vocation to teach. Few physics undergraduate, postgraduate and PhD students intend to go into teaching, especially considering the financial incentives to work in other sectors; research in England highlights the role that financial incentives can play in teacher supply, including in shortage subjects. Thus, we believe the Committee needs to examine how physics teaching can be made a more attractive option and how non-specialists can receive full subject specific training before commencing teaching.'*

In its submission, the Teachers Union of Ireland (TUI) referred to a widespread recognition of a teacher supply crisis. It noted that studies by management bodies, teacher unions and State agencies all give evidence of this. For example, a TUI survey of school leaders in October 2022 found that 91% of schools had experienced difficulties in hiring teachers in the previous six months. Problems were reported in almost all subjects but the biggest difficulties were reported in the areas of Maths, Irish, Home Economics, Chemistry and French.

In oral evidence, on 28 February 2023, Mr. John Curtis, General Secretary, Joint Managerial Body (JMB) commented that '*The reasons underpinning the severe shortage of teachers who are qualified and registered to teach STEM subjects requires investigation because it provides important indicators of the policy-level direction required for us to emerge as a high-capacity education and, ultimately, workforce contributor to the economy. Indicators that should be addressed include: the high cost of qualifying as a secondary school teacher and the risk of exclusion of particular social groups impacting on teaching workforce diversity; the duration of the teacher qualification and recognition processes and the attractiveness to graduates of career pathways other than teaching; the need to remain in constant touch with accelerating STEM-field developments; and the lack of supports in social and ethical education and their pedagogies as they relate to STEM areas of learning and life. The good news is that our educators are not short of motivation. What is needed is a coherent framework under which their innate love of their subject areas, their indisputable agency and innovative capacities and their student-centred approaches to their vocation can offer a perfectly aligned set of conditions in which STEM education can be invigorated as a national priority'.*

TEACHER TRAINING AND UPSKILLING

The TUI submission referred to the difficulties in initial teacher education (ITE) post-primary, specifically students having to spend up to six years studying to be a teacher. It noted that there is a substantial financial cost to such study but also a very large opportunity cost to the student of not having an income for six years. It noted that '*TUI has long made clear that the duration, and cost, of initial teacher education discourages students from choosing to enter teaching careers.'*

In oral evidence, on 7 March, Mr David Duffy, Research Officer, Teachers Union of Ireland (TUI) expanded on this '*Regarding role models, we could certainly benefit from more diversity in the teaching profession. A number of colleagues in higher education institutions along the west coast have done a lot of work on this. The big issue probably relates to the opportunity and financial cost after a longer period of initial teacher education. In many cases it can take six years. Someone contemplating spending six years in college studying to be a teacher needs to have quite a bit of social capital and financial capital to begin with. That would help in getting a more diverse teaching profession.'*

In oral evidence, on 7 March, Professor Lisa Looney, Vice President for Academic Affairs and Registrar, DCU, expanded on teacher upskilling *'We will never stop needing continuing professional development for teachers at a very high level. The closer we get to the teacher in the classroom, the more impactful the change will be. We must be able to model good practice with our teachers, show them what it looks like and bring industry and higher and third level into the classroom so teachers can see what it is all about. I am concerned we are not seeing that at post-primary level. It is a huge area we may need to look at collectively. We must examine upskilling programmes for teachers. We talk about teacher supply and the lack of teachers in areas. There are a cohort of teachers who 30 JEFHERIS are excellent at their jobs and, perhaps, with another 60 credits of upskilling, could teach maths, biology or engineering and could transfer. We need to examine more technology and using shared teachers across the system. If we do not get the teaching right, all the other things do not* *fall into place. We must focus on that quality at this point and investing in that, at primary, post-primary and initial teacher education level.'*

In its submission, the Irish Second Level Students Union (ISSU) recommended that STEM teachers are trained and upskilled so that they have the relevant skill set required for the integration of the Digital Strategy.

In oral evidence, on 28th February 2023, Mr. Martin Gormley, Director of Schools, Donegal Education and Training Board, representing Education and Training Boards Ireland (ETBI), gave the following insights into training and upskilling '*Training and support in STEM for school leadership should become part of a professional development model to ensure that all leaders have the relevant knowledge to drive the STEM agenda in schools. If leadership is not coming from the top and from management, it may not happen in a school. Oide, the new body that will encompass the professional development service for teachers, junior cycle for teachers, the centre for school leadership and the national induction programme for teachers, will also provide an opportunity. The coincidence of this integration, alongside the redevelopment and implementation of a new curriculum, a junior cycle programme and a revised senior cycle, provides a significant opportunity to harness the strength and experience of these existing services to embed and fully realise STEM.'*

Mr Gormley also outlined in his evidence current upskilling models that could be used '*The University of Limerick has a qualification in project maths for out-of-field teachers. This has significantly reduced the number of teachers in the classroom who are not qualified in maths. Perhaps a similar model for other STEM subjects might be worth considering. We have had a problem with junior cycle coding and computer science at leaving certificate level but we have been working with Atlantic Technological University on upskilling teachers to be able to deliver on it. A similar model to that for maths replicated for other subjects would be both useful and helpful.'*

In its submission, the Higher Education Authority (HEA) stated that there needs to be a focus on providing targeted training in each school, relative to the size of the school, to promote informed inhouse leadership in STEM education.

In oral evidence, on 28th March 2023, Ms Claire McGee, Irish Business and economic Federation (IBEC), emphasised the importance of teacher training, by stating '*many European and international studies have highlighted the importance of strengthening teacher competencies in STEM areas and industry can play an important role in facilitating teacher training through placement opportunities for initial teacher education and co-teaching by industry staff, as well as opportunities for career guidance and service teachers to gain an understanding of the needs of the evolving industries.'*

In oral evidence, on 18 April 2023, Dr Cornelia Connolly, Associate Professor, School of Education, College of Arts, Social Sciences & Celtic Studies, University of Galway noted that '*There is a shortage of teachers in computer science education globally. We have to think creatively around how to upskill teachers. There is a very successful professional diploma for mathematics teaching, which is ongoing over recent years through University of Limerick and University of Galway. Offering a similar programme to those teachers in our system to upskill and become qualified computer science teachers would be an easy win. We need, however, to incentivise people into computer science education and encourage more into the education space. The internship programmes for student teachers is an obvious choice, as is expanding and showing the range of skills possible within computer science education. We must also be conscious of the learning pathway. It is very difficult for students to select computer science or a STEM teacher education programme coming from their leaving certificate if they have not studied the subject in secondary school.'*

In its submission, An Chomhairle um Oideachais Gaeltachta agus Gaelscolaíochta (COGG) outlined proposals to ensure that Gaeltacht and Irish-medium schools are on an equal footing with the other schools in the system both now and in the future for STEM provision in Primary and Post Primary Schools. To this end, it was noted that the availability of qualified STEM teachers with fluent Irish will be crucially important.

In oral evidence, on 25 April 2023, Mr. Diarmaid Mooney, Acting Director, Curriculum and Assessment, National Council for Curriculum and assessment (NCCA), reported that '*the NCCA is looking at the potential of virtual learning environments. It was built on a request that came from the Minister. Through our own research we also picked up on the physics in the Gaeltacht initiative. We are trying to build on that now and looking at what is possible. There was a shortage of physics teachers in Gaeltacht schools. This was an online initiative that was developed so that physics could be delivered in one school but other schools may join in at that point in time. We are engaging in a piece of research this year to examine the potential of virtual learning environments, VLEs, in particular in terms of subject spaces, the likes of transition year and non-attendees at school. Where there may be a shortage, we are considering the potential of the online environment.'*

INTEGRATION OF STEM INCLUDING TRANSITION YEAR (TY)

The NAPD submission makes the point that '*the development of STEM skills cannot be the sole responsibility of the STEM subject teachers.'* It and other submissions also refer to curriculum overload and the inherent dangers in this that essential learning is prioritised and skill development is minimised.

The NAPD states that curriculum overload can be an issue for many students at Senior Cycle, particularly when they are studying subjects they are not interested in and may feel they are not good at. It advised that reducing the curriculum content for students has the added advantage of creating time. It would give time for reflection on the learning, for exploration, experimentation and for embedding the skills, many of which are also the STEM skills that students will have been developing since primary school.

Mr Paul Crone, NAPD, expanded on this *stating 'It is humanities, ethics, creativity and imagination. These, I suppose, are at the other side of STEM but they are not really. They integrate with each other and we cannot ignore one for the want of the other. People are successful in STEM subjects when they have a good basis in the humanities in that they exercise ethics, are creative and can use their imagination.*

We have to look at the holistic and well-rounded individual which is very important for our system.'

The Irish Science Teachers Association (ISTA) in its submission was emphatic that the current template of syllabus design should be replaced by a template which reflects international best practice. It recommended that '*A new syllabus template needs to be developed for all syllabi at Junior Cycle and Leaving Certificate level. This template must contain more detailed information about the depth of treatment of subjects including the linking of learning outcomes to teaching and learning activities and to assessment.'*

Dr Áine Hyland, stated that *'there is a mismatch in a way between current developments, such as the changes in the junior cycle and leaving certificate, and the examination and assessment, the State Examinations Commission and the NCCA, which has been pointed out before. There are also the very skeletal programmes, syllabi or specifications, as they are called, that are coming out now for the proposed new leaving certificate subjects. I do not think they give enough information to teachers and they do not go into sufficient depth. There is a real risk that standards will begin to fall.'*

In oral evidence, on 21 March 2023, Mr. Humphrey Jones, Irish Science Teachers Association (ISTA), once again expressed concerns about the syllabi '*The ISTA reiterates our commitment to supporting Ireland's STEM education plan, but we feel the current syllabus design model is a significant barrier to achieving its ambitions goals. We would like the committee to reiterate that several provisions must be made for the successful implementation of STEM subjects. A new syllabus template needs to be developed for all syllabi at junior cycle and leaving certificate level. A full range of documentation must be available before implementation of the syllabi. This must include teacher guidelines, practical coursework guidelines, sample examination papers and sample marking schemes. We recommend an external, independent evaluation be carried out on the junior cycle framework and the leaving certificate subjects that have already been implemented using the same template. This external evaluation should be carried out by personnel from outside Ireland and by experts in curriculum design.'*

In its submission, the Teachers Union of Ireland (TUI) asked '*that work resume as quickly as possible on the revised specifications for Physics, Chemistry and Biology which have been on pause since the Minister's Senior Cycle announcement of March 2022.'*

It also referred to the current uncertainty about the future of the combined Physics/Chemistry course at Senior Cycle. It sought confirmation from the Department of Education that this course will continue.

Several submissions referred to the need for curricular concessions to address teacher allocation and subject availability. Ms Moira Leydon, ASTI, stated 'A *dilemma which frequently faces schools is that they want to offer physics or chemistry, which are minority subjects anyway. To employ a physics or chemistry teacher, that teacher must also have a number of other subjects. There may not be sufficient demand to create a full-time, permanent post for that teacher. Decisions are made about what to prioritise. The unions have consistently responded that there should be, as Mr. Duffy said, curricular concessions in terms of teacher allocation and additional teachers allocated to the school to facilitate a wide curriculum. We have also made the point, which is a view the three teacher unions share, that we should be able to give teachers permanent jobs but they are shared between schools.'*

Several submissions raised the issue of gifted and talented students and the need to offer them additional supports so they can reach their full potential. The TUI Submission noted that '*In terms of international comparators the one notable negative for Ireland is our performance in terms of whether very high-achieving students in Ireland are being sufficiently challenged*.'

In oral evidence, on 28 February 2023, Mr. John Irwin, General Secretary, Association of Community and Comprehensive Schools (ACCS) stated' *That whole area of the performance of our highest performing students needs to be looked at it. In TIMSS, we have the same finding. Performance among the highest achieving students is somewhat poorer when compared to their peers in countries with similar overall performance. This is the key issue we need to address at the top level of our education system.'*

Professor Lisa Looney, DCU made the point '*we echo concerns expressed by others to this committee that the Programme for International Student Assessment, PISA, data show the higher performing cohort in Ireland is behind its peers internationally in mathematics.*'

The HEA Submission recommended that the revision of the Leaving Certificate/Senior Cycle curriculum and assessment needs to:

- ensure that all types of learners are catered for
- active learning and assessment approaches are integrated for STEM as well as cross curricular, - embed digital technologies in teaching, learning and assessment.

TUD submission proposed that TY programmes include engagement with local STEM industries and site visits to hi-tech manufacturing plants, data centres, Universities, museums, etc.

In oral evidence, on 7 March 2023, Ms Caitlin Faye Maniti, Irish Second Level Students Union (ISSU), expressed the view that '*ISSU welcomes the plan to implement the updated subject curricula mentioned in the senior cycle redevelopment publication in relation to the STEM subjects of biology, chemistry and physics. STEM needs to be more relevant to students. Many are just rote learning chemicals and experiments and not actually understanding what it is they are studying. Even laboratory subjects are taught to the exam. Some chemistry students may never perform a titration and can still get a H1 despite this. This is a massive oversight and senior cycle redevelopment presents an opportunity to rectify this and make STEM subjects engaging and relevant for students. The new leaving certificate climate action and sustainable development subject presents a rare opportunity for students to study a fast-evolving science relevant to their daily lives. The ISSU would like to take this opportunity to mention our recommendation for climate science to be included on the course which would further develop young people's passion for STEM.'*

In oral evidence, on 18 April 2023, Mr Liam Carew, 2023 Young Scientist of the Year, referring to the findings of his winning entry, noted that *'Along with the* *aforementioned areas, students were also surveyed on the extent to which they felt second level education equipped them with the skills to progress in life. In this question, transition year students rated the lowest. Given that STEM is a skills-heavy field, this indicates a significant opportunity for the transition year programme to be more reflective of the value of STEM in acquiring skills.'*

In oral evidence, on 18 April 2023, Mr Shane O'Connor, 2023 Young Scientist of the Year, spoke about the value of competing in the Young Scientist of the Year '*People are applying skills they are learning. This was our second year competing in the competition and it was great to meet people who have similar interests to us and compete against them. The buzz of the whole competition was great. What we have learned since has been even more valuable.'*

INVESTMENT IN STEM RESOURCES

In her written submission, Ms. Norma Foley TD, Minister for Education, stated that the STEM Education Implementation Plan to 2026, developed by the Department of Education and the Department of Children, Equality, Disability, Integration and Youth, is to be published shortly.

The Minister referred to the consultation process, and that it identified various challenges to the provision of quality STEM education within schools. These included the gap in understanding of what integrated STEM looks like at primary level, the value put on STEM within the schools and external evaluations and the limited capacity in the provision of STEM subjects in post-primary schools. It also identified the need to provide additional support to educators in relation to their STEM content knowledge, particularly in relation to subjects where there is a shortage of staff, and the challenges in relation to ensuring that student teachers have opportunities to teach a STEM lesson while on placement.

Significantly, she explained that the Departments of Education and Further and Higher Education, Research, Innovation and Science '*will lead on the programme of work and will work with all STEM education stakeholders to address the challenges identified and realise the ambitious actions.'*

ROLE OF GUIDANCE COUNSELLORS

In its submission, the Expert Group on Future Skills Needs (EGFSN) opined that the expansion of the domestic pool of STEM professionals will rely to a significant extent on the more effective channelling of students towards programmes, and ultimately employment, in areas of identified skills needs and the addressing of barriers to STEM course and career choices. It contended that developing a skills identification and intelligence system, which can provide sufficiently granular information to effectively inform and maintain the relevance of education and training in such a fast-changing environment, will be central to this ambition.

It further advised 'the *development of a properly resourced and informed career guidance system and pool of guidance professionals, at secondary and tertiary level, which is more attuned to labour market trends, emerging and evolving career opportunities, and the variety of pathways into associated STEM careers. The targeting of parents, a key formative influence on career choices, will also be important.'*

In oral evidence, on 7th March 2023, Ms Moira Leydon, Assistant General Secretary, Association of Secondary Teachers in Ireland (ASTI), outlined the key role played by Guidance Counsellors and the resources required '*We have been here before to talk about guidance counselling in education. One fundamental dimension of equality in education at second level is making sure that, from the moment students enter second level education, they have that scaffolding, nurturing, pastoral care and guidance about and consequences of subject choice from the very start. At the moment, the allocation ratio means that a school of 500 pupils will get a person in the post for 18 hours. The typical teacher's post is for 22 hours a week. A school of 500 pupils is allowed a guidance counsellor for 18 hours, which is not a full post. That increases to 26 hours, which is a teacher and a quarter, for a school of 700. Our guidance system needs massive investment. We acknowledge the Department has put in place innovative, out-of-field training programmes for teachers in physics and chemistry, which is welcome. We need to keep up that because it is critical'.*
In oral evidence, on 28 March 2023, Ms Helen McMahon, Senior Strategy Policy Adviser, Enterprise Ireland (EI) introduced an interesting concept'……*once they*

move to the next level and are in secondary school, it gets much more into life mapping of lifelong career guidance and looking at career trajectory. Obviously, that goes further in their career in terms of career pathways. Again, it is about mapping out the age of the individual and how you interact with people through different stages of their growth. It is also then about mapping out the roles so that the career guidance professionals can have the knowledge to explain that to children and parents, who are, as everybody knows, hugely influential on their development at this stage.'

PROMOTION OF APPRENTICESHIPS

In its submission, the National Apprenticeship Office, recommended the development of additional targeted initiatives for primary and second level schools. It refers to the speed at which apprenticeships are being developed, and, how, within 1-2 years it is likely that up to 100 programmes will be available, with a large proportion of these in STEM areas. It states that schools, school principals, teachers and guidance counsellors play a key role in developing awareness of STEM education and apprenticeship opportunities. It proposes a coordinated programme of taster courses, competitions for teams and individuals, showcase events, briefings for staff as well as students.

The TUI Submission stated that apprenticeships need to be valued by Irish Society and other submissions and oral evidence given echo these sentiments.

Mr John Irwin stated that '*Apprenticeships are greatly undervalued in this State. When we look at how the media portray achievement, it is all about going to universities. They totally undervalue different styles of learning. The apprenticeship is such a valuable manner of learning. I am delighted that ETBs are becoming more engaged in the further education area and trying to rebuild what was basically torn down 20 years ago when people stepped away from vocational education. It was one of the great regrets in education that people stepped away from vocational education and stepped away from the value of the apprenticeship. Apprenticeships were just completely undervalued as a style of learning and what they promoted. I know some of my colleagues in the media will probably disagree with me on this, but* *some of that was media driven because what we highlighted as being important was the university or the IT and apprenticeships were very much second class'.*

In oral evidence, on 28 March 2023, Mr. Michael Fitzgerald, Technical Training and Development Manager, ESB Networks, outlined their apprenticeship programme '*We make a great deal of effort to promote our apprenticeships. We do this through our apprentices themselves, who are advocates to their peers and act as a bridge to parents, teachers and schools. We have a very active campaign of school visits with 55 visits to different schools in 24 counties last year. Of those schools, 21 were DEIS schools. We also have a very significant programme of work with third level partners promoting science in DEIS schools, where people come in for a day and do technical skills. The plan would be that they would then choose STEM subjects in secondary school to give them an option of becoming an apprentice. We also do an ESB Science Blast programme, which reaches 20,000 school children at primary level every year. The plan there is to make science attractive and fun and to help people to break down whatever perceived barriers they may see around practical skills. It gives students the option to pick the right subjects so they can go on to be apprentices or in our case, to go on to be engineers from apprenticeships.'*

Mr. Jamie Bermingham made the salient point that '*A lot more could be done in transition year. I did my work experience in a garage, which was a big thing for me. It was kind of the dealbreaker. I knew after fourth year that this was what I was going to do. There definitely should be much more emphasis in school around apprenticeships. Schools should be pushing them more. Doing an apprenticeship is fantastic.'*

In oral evidence, on 25 April 2023, Dr Liz Ann Trant, Director, National Apprenticeship Office, recommended that national and regional awareness and promotional campaigns include STEM apprenticeships alongside other options and include information on the specific opportunities and benefits offered to those choosing the apprenticeship route. Also, she recommended that additional targeted initiatives are developed to promote STEM opportunities and apprenticeships in STEM areas to reach young people from the earliest age.

At the same meeting, Mr Andrew Brownlee, CEO, stated that SOLAS and the ETBs have worked to provide more access to taster modules during transition year to encourage interest and skills development in STEM-related areas and to signpost future potential pathways. Areas of focus have included mechanics, aviation, electrical, plumbing, green skills and healthcare. As part of their strategic performance agreements with SOLAS, all ETBs are required to develop the transition year offerings further in the next two years. He explained that SOLAS has also been working closely with the NCCA to further embed this approach.

RECOMMENDATIONS: POST-PRIMARY EDUCATION

10. Junior Cycle Short Courses should be expanded to include more integrated STEM options.

11. Foundation Level Mathematics at Junior Cycle should be reintroduced to ensure that weaker students engage with the subject in a positive way.

12. The Department of Education should publish revised specifications for Physics, Chemistry and Biology at Senior Cycle by the end of 2023. A key priority should be that the revised syllabus for each subject is far more detailed with comprehensive instructions for teachers. The Committee recommends that the National Council for Curriculum and Assessment (NCCA) reviews the proposed design of the new specifications to ensure teachers are properly supported and students are taught to the highest professional standards.

13. Modularisation should be introduced for STEM subjects, to comprise:
    - Written assignments prepared in class under the class teacher’s supervision, marked by the State Examinations Commission (SEC), with a broad range of options to give student’s the maximum freedom to select topics as a way of encouraging self-directed learning.

- An oral presentation using power point slides on the selected topic, recorded and assessed by the class teacher with external validation checks by the State Examinations Commission (SEC).

It is recommended for all subjects, that 2 Modules are completed over Senior Cycle, one in 5th and 6th Year. A written examination would then take place in each subject at the end of 6th year. The Marking Scheme should be determined by the Department of Education in liaison with the National Council for Curriculum and Assessment (NCCA) and the State Examinations Commission (SEC).

14. All Senior Cycle students should have the option of combining traditional Leaving Certificate (LC) and Leaving Certificate Applied (LCA) STEM Subjects. To this end, the Department of Education, in liaison with the National Council for Curriculum and Assessment (NCCA), should review the LCA Model, to identify how the evidentially successful parts of it regarding STEM could be incorporated into the traditional Senior Cycle.

15. Supporting integrated STEM work in Junior Cycle will require teachers with understandings across Physics, Chemistry and Biology. Teaching Council Registration requirements should stipulate that teaching credits are required in all three subjects to teach Science at Junior Cycle.

16. An *Expert Working Group on Teacher Supply for STEM Subjects and Computer Science* should be established by the Department of Education in Quarter 4, 2023. The Group should be chaired by an external expert and comprise teachers, the National Council for Curriculum and Assessment (NCCA), Relevant Teacher Training Institutions, Subject Matter Experts and senior officials from the Departments of Education and Further and Higher Education, Research, Innovation and Science.

17. In the interim, the Department of Further and Higher Education, Research, Innovation and Science should seek Expressions of Interest (EOI) from Higher Education Institutions regarding the provision of Post Graduate Accreditation to teach Computer Science at Senior Cycle to Honours level.

18. The Ministers for Education and Further and Higher Education, Research, Innovation and Science, should jointly review the Teaching Council Regulation that precludes Technological Universities from ‘taking the lead’ in Teacher Training Provision and amend the legislation, if necessary.

19. The Department of Education should develop a *National Programme for High Performing Students*[3] in Primary and Post Primary Schools to enable them to reach their full potential. The Department should engage with the Centre for Talented Youth (CTYI) in Ireland at Dublin City University (DCU) in this regard with a view to agreeing on a Service Level Agreement (SLA) that would include, *inter alia*, Training for Teachers in Programme Delivery. The Programme should be rolled out nationwide so that all relevant students have equal access to it.

20. The State Examinations Commission (SEC) should review the Junior Cycle and Senior Cycle Mathematics Papers so that students with low or poor literacy levels are not placed at a significant disadvantage.

21. Integrated STEM options in Transition Year (TY) should be available in all Post Primary Education Settings to help promote a STEM Culture.

[3] High Performing Students should be identified primarily on the results of the Drumcondra Standardised Tests in English and Mathematics from Second Class and onward.

22. An Integrated STEM project should be incorporated into the Transition Year curriculum and awarded credits towards the terminal Leaving Certificate Examination Result in the relevant subject.

23. The Department of Education should establish an *Online Streaming Initiative* within DEIS Schools as a pilot initiative, so that students have the choice to study all STEM subjects at Higher Level. The selected schools should have a geographic spread. Pending evaluation, the Initiative should then be rolled out nationwide as a Model of Best Practice. To this end, comprehensive training should be provided to participating teachers as well as Compensatory Allowances.

24. The Senior Cycle Curriculum should prepare students for Apprenticeships, Further Education and entering the Workplace.

25. The Ministers for Education and Further and Higher Education, Research, Innovation and Science should develop a joint *Apprenticeship Communications Campaign* that can be rolled out to all Secondary Schools.

26. Whole School Inspections (WSE) should be used to track schools progress in promoting Science, Technology, Engineering and maths (STEM) and offer support to nonparticipating schools.

27. A Mandatory Module on supporting integrated STEM Education should be provided to all Guidance Counsellors as part of their Continuous Professional Development (CPD). It should include, *inter alia,* awareness of STEM roles, career opportunities and role models.

CHAPTER 3 TERTIARY EDUCATION

CAPITAL AND INVESTMENT

In its submission, the Irish Universities Association (IUA) noted that ‘there has been a significant lack of capital investment in IUA universities since the onset of the financial crisis, resulting in sustained pressure on campus spaces and facilities for teaching and learning, research, and student services. Over the past decade student numbers in the higher education sector have grown by 25%. Exchequer capital funding available to IUA universities over that period however has effectively been limited to two funding calls of c. €80m each under the Higher Education Strategic Infrastructure Fund. In the absence of Exchequer funding, universities have had to borrow heavily over this period to meet this increase in capital infrastructure needs. Some universities are now at the end of their borrowing limits and will not be able to meet the expected demographic increases coming over the next decade.

Significant Exchequer capital investment in IUA universities is now required to meet the demographic pressures and changing needs of students. In the absence of that funding, the continued capacity of universities to expand STEM provision and produce high quality graduates will be significantly impacted.’

Professor Lisa Looney, DCU, expanded on this further stating that ‘*to capitalise on STEM education to address skills needs, including skills focused on the challenges of climate change and the digital transition, we need a policy focus on scaling the provision of STEM programmes at third level. We also need a broader strategy for lifelong learning, including reskilling and upskilling to unlock the potential for STEM participation and inclusion. IUA institutions have been proactive. We have absorbed a significant number of additional STEM enrolments over the last six years. Despite this and the support of the Human Capital Initiative, funded from the National Training Fund, shortages of STEM graduates exist very broadly. If anything, emphasis on areas such as ICT and engineering seems to have reduced and policy shifted to shortages in health-related disciplines where Government is the main employer. We cannot afford to reduce emphasis on the physics, sciences, ICT and engineering aspects of STEM. We are far from meeting the skills challenge currently and that has a very negative impact on competitiveness.’*

The HECA submission noted that although higher education offers specialised courses in STEM fields, it's crucial to provide not only advanced degrees and post-graduate courses in these subjects, but also interdisciplinary modules that can be integrated with other areas of study. It further noted that Microcredentials will play a key role in enabling this type of dual-skilling and will also aid in enhancing the digital literacy of adults as well as lifelong learning and upskilling.

It stated that HECA member HEIs are strong supporters and providers of existing programmes such as Springboard+ and Human Capital Initiative (HCI) Pillar 1 which offer upskilling and reskilling opportunities in STEM career. It noted that to level the playing field for underrepresented groups and address the digital divide, there is a need to increase the provision, methods and integration of STEM into tertiary education. It cited the increasing importance of technology in today's world and how it is crucial that everyone has access to the skills and knowledge necessary to thrive in the digital age.

The EGFSN submission stated that expanding the pipeline of initial entrants into STEM professions will need to be accompanied by a robust approach to the regular upskilling of the existing STEM workforce across Further Education and Training and Higher Education, to ensure it keeps pace with technological, environment and scientific trends.

It made the point that this is already a key priority of Ireland’s approach to lifelong learning, which is extensively supported through the either free or heavily subsidised programmes funded through the National Training Fund. These include Springboard+, the Human Capital Initiative, Skillnet Ireland’s enterprise led training networks, and a range of programmes across the Education and Training Board network. It highlighted that the new industry consortia led apprenticeships, which are now offered across STEM disciplines including Biopharma, Engineering, and ICT, are also offering reskilling pathways for those transitioning from other job roles or sectors, as well as graduates from initial education.

The TUD submission noted that. as the STEM sector is fast evolving, investment is required to keep tertiary educational institutions equipped to teach the most up-to-date knowledge. Investment funding for infrastructure and equipment, ideally on a multi-annual basis, is important to enable optimal planning of educational offerings.

It also contended that Level 9 and level 10 education are quickly becoming the new norm for high skilled jobs in the STEM sector. It advised that Investment in research infrastructure and funding streams is required to upskill level 8 STEM graduates to attain higher degrees (in particular, in the areas identified in the National Research Prioritisation Exercise). It noted that sufficient funding schemes should be in place to support the parallel upskilling of employees through employment-based research.

In oral evidence, on 7 March 2023, Ms Beth O'Reilly, President, Union of Students in Ireland (USI) contended that '*There is also a need for an increase in the amount of STEM-focused programmes available at third level. This could involve creating new degree programmes in emerging fields like data science and cybersecurity, creating additional optional modules for students in these areas or expanding existing programmes to accommodate additional students.'*

Ms Claire McGee, IBEC, opined that *'investment in enhancing high-level STEM capacity across further and higher education. In addition to improving the pipeline and enrolment numbers across the tertiary and apprenticeship system, focus must also be on delivering a high-quality STEM education experience, with a strategic capital investment programme for cutting-edge technology, equipment 28 MARCH 2023 17 and infrastructure. To educate, train and empower the next generation of scientists, engineers, architects, teachers, medical professionals, artists, apprentices and so on, Ireland's universities and colleges must have state-of-the-art equipment to provide a high-quality learning experience. IBEC has long advocated for greater investment in STEM education. The current unit of resource funding does not reflect the full economic cost of delivery. This must be addressed by the provision of capital infrastructure renewal, development and upkeep. Otherwise, universities and colleges will not be able to develop critical technology and digital skills. Innovative talent development models, such as the new consortium-led apprenticeships in STEM-related disciplines, need to be accessible and financially viable for all enterprises.'*

STEM RESEARCH AND INNOVATION

In its submission, Science Foundation Ireland (SFI) warmly welcomed and support the introduction of the Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) Evidence for Policy Unit and associated Civil Service Management Board approval of a proposal to establish Civil Service Research Network (CSRN). It opines that the body has the potential to create a meaningful path for engagement between policy makers and the academic community.

The IUA submission made the point that '*the development of a research funding agency is an exciting opportunity to enhance links between higher education, schools, and the community. Championing the role of university researchers across the STEM disciplines, as well as engaging wider society in the role of STEM in addressing societal and economic needs can be better supported as a result. Irish universities have performed strongly in research and innovation, especially in securing recent EU Horizon 2020 and Horizon Europe funding. These successes build on the capacity of our universities to develop research-informed programmes at undergraduate and postgraduate levels, as well as to develop short courses such as micro-credentials to meet emerging skills needs.*'

EMPLOYMENT PRECARITY AND CAREER PATHWAYS

The SFI submission and others similarly contended that PhD candidates and postdoctoral researchers are the lifeblood of the research and STEM higher education system. It opined that without adequate support for those individuals so that they can thrive in their endeavours, there is a risk of destabilising that pipeline of talent. Interestingly, it noted that women are most likely to leave research during those early years of their career, often termed the 'leaky pipeline'.

SFI welcomed the capital infrastructure programme and recommended that appropriate balance is sought to support infrastructural and indirect costs of research, *and* to support the allocation of academic time to scholarship and preliminary and exploratory research.

It also recommended the identification of the high-level (PhD and postdoctoral) skills required for the future to create a national talent roadmap to help secure the country's ability to respond to future societal, public service and economic needs.

In its submission, Irish Federation of University Teachers (IFUT) 'welcomed the Oireachtas Committee Report, entitled *The Future Funding of Higher Education,* which includes an examination of the needs of those in precarious employment and atypical contracts in higher education. It quoted the Report where it states it is …..'*imperative that Irish Universities ensure their research staff have employment contracts that offer security of tenure, career progression pathways and salary scales that are commensurate with their qualifications and experience*.'

IFUT also stated that it is imperative there is sufficient funding of STEM education in higher education to enable a sustainable higher education system and ensure students and staff alike are enabled to achieve maximum educational outcomes, while ensuring that higher education remains able to deliver the highest standards of research and teaching in STEM subjects and continue to support Ireland's social and economic development.

In oral evidence, on 7 March 2023, Mr Frank Jones, General Secretary, Irish Federation of University Teachers (IFUT) outlined the stark reality of working in precarious employment '*we have a lot of people who make commitments far beyond what has been recognised in salary or a contract and remain within the sector at enormous personal cost. In many cases, we are coming across members who are in their late thirties before they secure contracts of indefinite duration or tenure and it is only then that they can start to purchase houses and start families. We are not losing them all but those we are keeping are being kept at enormous personal cost to themselves. A lot can be done. If the recommendations and decisions of this committee were acted upon, a lot would be done.'.*

The IUA submission made the point that the current review of State Supports for PhD Researchers is an opportunity to consider the full progression of students from primary through to research. It notes that doctoral education provided by our universities must meet an ever-growing need for research personnel across academia and industry. For example, 80% of natural sciences, mathematics and statistics PhD graduates felt their qualification was relevant or very relevant to their job highlighting the need for high-level research experience for the knowledge economy.

The TUD submission stated that '*Ireland has invested in Technological Universities to help deliver its national ambition for STEM but has not yet invested in the appropriate staffing of the sector. The recommendations contained in the recent OECD 'Review of Technological University Academic Career Paths, Contracts and Organisation in Ireland' need to be implemented by government, including both the academic workload model (to encourage greater research output) and the career framework (to enable the sector to compete for talent with longer established universities).'*

In oral evidence, on 28 March 2023, Dr Ruth Freeman, Director of Science for society, Science Foundation Ireland (SFI), reported that '*the Department of Further and Higher Education, Research, Innovation and Science is carrying out an ongoing review of the structures to support PhD students. In reality, the stipend to students has remained the same for many years and it has been highlighted that it has not kept up with the cost of living for students. As a result, and to quote some of the researchers that we fund, they are either unable to attract students to take up PhD positions or the pool of students they can attract is restricted to those who can perhaps stay in their parents' homes within commuting distance of the laboratory where they are going to do their work. The rising accommodation costs and the cost of living mean that those who do not have those supports are unable to take up these opportunities.*

The implications for us, as a society, are that we are excluding people from certain socioeconomic backgrounds from taking up these opportunities in STEM and we are not opening up the widest talent pool we can to build a world-class research system *here in Ireland. We, therefore, welcome the review. The review will look at a number of different lenses. In other European countries, PhD students are regarded as staff members whereas here they are treated as students. I think the review may look at that aspect but certainly the level of the stipend is the urgent issue today.'*

LIFE LONG LEARNING, PROGRESSIONAL PATHWAYS AND CONTINUOUS PROFESSIONAL DEVELOPMENT (CPD)

The TUD Submission proposed the consideration of an alteration of the CAO points system, or development of pathways through Further Education establishments, to allow students with strengths in particular STEM subjects to gain access to relevant programmes at tertiary level.

The NAPD Submission opined that the creation of diverse pathways for students is essential to an integrated system to allow for students to follow their passion. It further stresses that diverse and varied pathways will create more opportunities for students and create the conditions to break down barriers to studying STEM courses in tertiary education. In addition, many students, who all mature at different rates, can be excluded from access to STEM courses based on a matriculation requirement that is based on their performance in the Leaving Certificate. It notes that a significant number of mature students enrol in STEM courses that had previously failed to gain access to the course directly following their Leaving Certificate or had dropped out proving diverse pathways will likely increase participation in STEM courses at tertiary level.

In its submission, Enterprise Ireland (EI), opined that increasing the number of students choosing STEM pathways in Further and Higher Education, and the quality of that education across all levels of the National Framework of Qualifications (NFQ) is key to any policy statement on STEM education. It also stated that it is equally important to ensure people sustain their involvement in STEM education throughout their careers by promoting lifelong learning, progression pathways and continuous professional development.

The submission referred to life-long learning and noted that is essential to sustain and develop a skilled workforce that can adapt and respond to changing skills needs.

To achieve this there must be clear and integrated pathways between Further and Higher Education. It stressed that this focus is very important to support inclusion and diversity, building a pathway of progression that is accessible and supports individuals to build their career and provide development opportunities.

In oral evidence, on 28 March 2023, Mr Neil McDonnell, Chief Executive, Irish Small and Medium Enterprises (ISME) made an interesting point '*While Ireland's performance at secondary and tertiary levels is good by international comparison, this comes at the expense of a significant degree of overeducation relative to job requirements. This is estimated by the Economic and Social Research Institute, ESRI, and the Institute of Labor Economics as being at 30% in Ireland. On its own that would not be problematic, but we see our academic education system outperforming while vocational and lifelong learning underperform. This should be at the forefront of the advancement of STEM in the Irish education system in future.*'

Several submissions refer to the value of the National Youth Council of Ireland (NYCI) STEAM in Youth Work Project and the National Adult Literacy Agency (NALA) proposed that it could be considered as an existing framework.

The IUA submission proposed a coordinated action plan that is inclusive of the significant role that higher education plays in meeting STEM skills needs cross-sectorally, through primary to tertiary. It stated that the plan for an integrated tertiary sector is an opportunity to achieve this aim.

It also referred to the need for a broader strategy for lifelong learning, including re-skilling and up-skilling, to unlock the potential for STEM participation and inclusion across an individual's educational and careers journey.

The EGFSN stated that expanding the pipeline of initial entrants into STEM professions will need to be accompanied by a robust approach to the regular upskilling of the existing STEM workforce across Further Education and Training and Higher Education, in order to ensure it keeps pace with technological, environmental and scientific trends.

In oral evidence, on 28 March 2023, Dr Aisling Soden, Talent Transformation & Innovation Manager, Irish Development Authority (IDA), noted that '*We must also* *look for diversity within the talent pool to broaden it through alternative pathways, not only in the traditional degree route but in looking at apprenticeships, for example, the unified tertiary system, and at further and higher education linking up and developing programmes so that people can move through to their chosen career.'*

In oral evidence, on 25 April 2023, Dr Peter Cullen, Framework Standards and Guidance Manager, Qualifications and Quality Assurance Ireland (QQI) noted that universities and higher education institutions provide the primary educational formation for many STEM disciplines, and it is important that all members of society who could benefit from this formation can avail of it. He pointed out that he dominant route into higher education is via the leaving certificate. He suggested that it may be useful to reflect on whether this route is overly dominant and consider further developing alternative pathways alongside it, such as those involving further education and training

FUTURE EXPANSION OF CRAFT AND NEW GENERATION APPRENTICESHIPS

Ms Beth O'Reilly, USI, noted that '*Given that not all students can, or wish to, attend a traditional university or college, support for apprenticeships and vocational programs should be improved by providing financial incentives to industry players to encourage them to take on apprentices. We need to see an expansion in the apprenticeship system to include more STEM fields, as well as financial support aimed at apprentices and trainees.'*

Mr. Michael Fitzgerald, ESB Networks, explained that '*For generations, the apprenticeship system has been part of our philosophy and ethos in the ESB. Our investment in apprenticeships and in-career training is critical to ensuring we have the requisite skills to maintain, develop and enhance the electricity system so it meets the needs of modern Ireland. The apprenticeship model has worked extremely well for the ESB…... We have always sought to contribute to the development of apprenticeships in Ireland and worked closely with SOLAS and other organisations in areas such as standards and progression routes. Diversity of intake is essential for ESB Networks. This year 25% of first-year apprentices are female. This is the largest group in the country….. To continue to achieve the necessary standards, we must* *attract the highest possible field of potential candidates at recruitment stage. Apprenticeship promotion is multifaceted…Apprentices advocate a diverse, attractive and rewarding way to "earn as you learn" to degree level or beyond. To achieve authenticity, the material is created on site in ESB Networks, using actual apprentices 22 JEFHERIS and staff. We are linking with the Irish Career Guidance Association to arrange familiarisation events in 2023 and beyond. Over the years we have invested heavily in our apprenticeship programme, including non-traditional apprenticeships. These investments have been rewarded with a stream of talent into the company that is crucial to our business and to serving the nation in a very different energy future.'*

In oral evidence, on 18 April, Mr. Jamie Bermingham, gave a personal testimony supporting apprenticeships *' I am a newly qualified plumber and WorldSkills Ireland plumbing and heating champion 2022. I would like to begin by saying that my apprenticeship has been a life-changing experience for me. Not only has it helped me to acquire the necessary skills and knowledge to excel in my chosen field, but it has also opened doors to numerous opportunities and experiences that I never thought were possible. I am proud to say that I succeeded well in my apprenticeship, achieving distinctions in all my exams and qualifying with an overall distinction. This was a moment of great pride for me…'*

At the meeting, Mr Martin Scattergood related his personal journey to a successful apprenticeship ' *I am a sheet metal worker and am now fully qualified now. At school, I liked science, technology, engineering and maths and I always preferred to be much more hands-on in my life. After doing the junior certificate examination……heard about the leaving certificate applied, LCA, through a friend………I moved school and took the LCA ….This opened doors into an apprenticeship for me. When I left school, I had done all the subjects in school. I had completed projects. I had a lot of worksheets and so on. We had done big projects in school, so I was able to go straight into an apprenticeship. As someone who struggled in a normal academic leaving certificate class, I think students should have different routes available to follow a more practical route in STEM.'*

RECOMMENDATIONS: TERTIARY EDUCATION

28. Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) should establish the Civil Service Research Network (CSRN) by Q4 2024.

29. The issues of Staffing Levels and Precarious Employment in both the traditional and Technological Universities need to be reviewed urgently or by end of 2022 at the latest, by the Minister for Further and Higher Education, Research, Innovation and Science, in liaison with the Universities. Staffing Levels have not increased in line with extra students, courses and increased services provided by Third Level Institutes and, so, there needs to be an analysis / workforce plan of staffing requirements to restore staff levels. In addition, the Employment Control Framework is completely arbitrary and needs to be abolished. The aim must be to ensure there are sufficient staff at all grades to deal with the projected increase of students, extra courses and increased services. Regarding Precarious Employment, the Review should include an examination of Hourly Paid Academic Contracts, Researchers, Postgraduate Workers and outsourcing of Support staff roles.

30. An *Expert Working Group on Pathways from Further Education to Higher Education* should be established by the Minister for Further and Higher Education, Research, Innovation and Science. The Group should be chaired by an External Expert and be comprised of Senior Department and Higher Education Authority (HEA) Officials, the Irish Universities Association (IUA), the Union of Students in Ireland (USI), the Technological Higher Education Association (THEA), SOLAS, Industry Representatives and Staff Unions. The Group should identify current opportunities and barriers to progression from Further to Higher Education and establish how to develop links between both sectors that allow for more seamless progression.

31. The Higher Education Authority (HEA) should provide ring fenced funding to the Technological Universities (TU)s, as necessary, to ensure there is sufficient physical capacity and lecturer capability to deliver on the increased numbers of Craft and New Generation Apprentices. To this end:

- The Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) should provide Short Term Funding to bridge the gap.
- From 2024, the Department should provide Multi Annual Funding through a new Apprenticeship Fund.
- The Higher Education Authority (HEA) should commence a Review of the Craft and New Generation Apprenticeship Building Requirements by Q3, 2022, with the aim of delivering the buildings required to ensure Apprentices are educated to the highest international standards within a 3-year period.

32. The cost of apprenticeships and lack of financial support provided to apprentices needs to be addressed, as follows:

    - Providing financial support to eligible apprentices through the SUSI Grants Scheme for periods of Block Release and for the purchase of expensive tools and equipment, where necessary.
    - New generation apprentices should receive the same financial payment from SOLAS as the craft apprentices.
    - Additional financial supports should be given to employers to facilitate hiring apprentices with disabilities, those from minority backgrounds and female apprentices.

CHAPTER 4 – FEMALE PARTICIPATION, DIVERSITY AND INCLUSION

In its submission, the Higher Education Authority (HEA) noted that 30% of students entering higher education for the first-time study STEM. Nonetheless, a large gender gap is evident. While 43% of men study STEM, 19% of women study STEM, representing a 24-percentage point difference.

The HEA submission also refers to *The National Access Plan – A Strategic Action Plan for Equity of Access, Participation and Success in Higher Education 2022-2028,* published in August 2022. It explains that the inclusivity goal in the plan is an objective to consider how to achieve a more diverse student population across all programmes and all levels of study, both undergraduate and postgraduate. This is relevant for STEM with data in the Plan showing that, for example, just 4.9% of new entrants doing Mathematics in 2019/20 were from disadvantaged areas compared to 19.1% from affluent areas. Over the lifetime of the National Access Plan, a range of key performance indicators will be monitored to assess progress, trends, and diversity across STEM fields of study.

The SFI submission remarked that women and girls are underrepresented in several areas of STEM. It stated that less females take up most STEM subjects including physics, engineering, applied maths and computer science and that many female schools offer a reduced range of STEM subjects.

It referred to 2019 data that shows that only 68% of female schools offer science subjects, other than maths and general science, compared to 94% of male schools. It noted, that in 3rd year, only 27% of girls take a STEM subject, other than maths or general science, compared to 73% of boys. It further cited a 2021 iWish survey that revealed over three-quarters of teenage girls cite lack of subject choices as a barrier to a career in STEM. Chemistry and Biology are the only two subjects where there are more females than males sitting the Higher Leaving Certificate exam. In all other STEM subjects, there are more males than females sitting the higher paper.

In its submission, the Irish Primary Principals Network (IPPN) made a pertinent observation. It noted that that the biggest challenge to the promotion of STEM is the simplest one. If children – both girls and boys - are exposed to interesting, well thought-out, well-planned STEM lessons that build on their previous work, then they will be more interested in taking these subjects at second level. Research shows that, where interest is not developed by the end of primary, children do not take these subjects later.

The NAPD submission noted *that 'not all schools offer all subjects to all students. Some girls only schools do not offer woodwork or some of the other STEM subjects to students while access to the leaving certificate science subjects can be haphazard. While it is understandable that in smaller schools it may not be economically viable to offer all subjects where there is only small student interest in the subject, there is a responsibility to support the offering of STEM subjects to all students.'*

Mr Paul Crone commented that '*looking at the gender breakdown of the 2022 leaving certificate, where STEM subjects such as maths are offered universally the take-up is almost 50:50. It is probably 45:55 where girls are taking it at higher level. If you go to construction, technology or engineering, there is a much lower take-up. That is something we need to address. More and more girls are choosing STEM subjects and exploring the aptitudes they are discovering they have in these areas. We need to look at providing and offering these subjects universally to all students, rather than potentially making them go down the road to the boys' school just to access them. These subjects should be available in all schools.'*

In oral evidence, on 21 March 2023, Dr Maria Kyne, Dean of the Faculty of Engineering and the Built Environment, Technological University of the Shannon (TUS) Midlands Midwest, representing the Technological Higher Education Authority (THEA), expressed the considered view *'In talking to this committee, the Union of Students in Ireland emphasised diversity and the importance of a culture of inclusion in STEM and those are priorities we in the IUA echo. As an engineer and former executive dean of a faculty of engineering and computing, this is an area of particular interest to me. There are three short points I want to make around this area. We have had a sustained focus on women in STEM for more than 30 years. I know because I have been there for the past 30 years. This has delivered progress but at* *a frustratingly slow pace. We need to keep doing what we have been doing, but we need to add new thinking around things such as gendered perception of confidence, the difficulty of STEM, how we use role models and how career risk is perceived. We now have a much larger pool of young women with strong competence at higher mathematics than there was a decade ago, but that competence is not translating into a higher number of women choosing STEM at third level to the same degree. We should examine how that could be changed.'*

Several submissions, including IOP, advocated for a fuller spectrum of data to be collected and published to identify and tackle underrepresentation. SFI recommended a consolidated approach to data collection which allows policy makers to understand the diversity of our research base and to ensure that it is representative of Irish society and can deliver solutions for society's needs.

In its submission, AONTAS recommended that the Departments of Education and of Further and Higher Education, Research, Innovation and Science implement systems which provides comprehensive national data collection on how learners from groups who have historically faced educational disadvantage progress through levels 8 – 10 National Framework of Qualifications (NFQ) in higher education in STEM-related disciplines.

Aontas also advocated that both Departments jointly commission qualitative research to look at the experiences of learners from these marginalised groups in STEM-related higher education disciplines and use findings to inform policy and practice on STEM education.

The IFUT submission expressed concern that, women continue to be underrepresented in science, technology, engineering, and mathematics (STEM) fields and in STEM leadership positions. It cited the statistics that 41 per cent of those graduating with a PhD in science, mathematics and computing are women — lower than in the EU, but nevertheless within a 60/40 definition of gender balance. However, that '…*disappears when we look at those who are permanent Stem academics (only 35 per cent of whom are women, compared with roughly half in the*

*EU). The picture becomes even more unbalanced at full professorial leve*l [*Irish Times 27th May 2022].*'

The EGFSN submission noted that gender imbalance is of course not unique to Ireland. However, it opined that domestically it is impacted by differences in subject choices at school level- a reflection of longstanding subject segregation between girls' and boys' secondary schools. It advised that when tertiary study and ultimately career options are being formed, this limits horizons around potential career pathways and ultimately the pipeline into relevant education and training programmes.

It also highlighted the fact that female participation levels vary by the branch of STEM- 33% of those in Science and Engineering occupations were female in 2021; this was highest for chemical, biological and physical scientists (50%), followed by 39% for Science and Engineering technicians, and 32% for Production, Design and QC Engineers. In the Construction professions, including civil engineering, the share of females is roughly 20%. In terms of ICT occupations, 24% of the workforce was female in 2021; 26% shares were recorded for ICT Specialists and Project Managers and IT Technicians, and 17% for Programmers and software developers. This is also reflected in the breakdown of recipients of employment permits for high level ICT roles, with males accounting for between 73% and 77% of permits over the period 2019-2023.

Professor Sarah McCormack made the compelling argument that '*encouraging women into STEM is crucial for economic growth and competitiveness. Engineering is a field that drives economic development through technological advancements and infrastructure improvements. By tapping into the talent pool of women, who make up half of our population, we can expand the workforce and drive economic growth. Studies have shown that companies with a diverse workforce, including gender diversity, tend to perform better financially and have a competitive advantage.'*

Professor McCormack proposed innovative ways to encourage female participation *'Representation matters. Having visible role models can inspire and motivate young* *girls and women to pursue careers in engineering and other STEM fields. Showcasing successful women STEM professionals as role models in schools, universities and workplaces can help challenge gender stereotypes and encourage more girls to consider STEM as a viable career option. Encouraging gender diversity requires not only changing mindsets but also implementing supportive policies and practices in educational institutions, workplaces and the engineering profession such as flexible work arrangements, mentorship programmes, diversity and inclusion initiatives and bias training programmes. Women offer different viewpoints, experiences and approaches to problem-solving, which can lead to more innovative solutions and improved decision-making. In a world that is facing complex challenges such as climate change, sustainable development and technological disruptions, we need diverse perspectives in engineering in order to develop innovative sustainable solutions that address the needs of all people.'*

The TUD Submission outlined several initiatives to support inclusion and diversity in HEI participation, including support after graduation.

In its submission, Independent Living Movement Ireland (ILMI) noted that '*in considering the current and future approach of STEM, it is crucial to respect Ireland's commitments under the United Nations Convention on the Rights of People with Disabilities (UNCRPD) and particularly Article 24 of the Convention which articulates, "The State recognises that disabled people have the same rights as others to education"*.'

The submission referred to the lack of STEM subject choice at post primary level for students with physical impairment. It made the point that educators need to be made aware of the social model of disability, such as taking part in authentic Disability Equality workshops and talk directly with disabled students to ensure equal access to all STEM subjects as the disabled person is the expert in what they can and cannot do. It also stresses the need for flexibility in the use of Assistive Technology when required in practical classes and or the use of a personal assistant to carry out tasks on the professional direction of the student. It also points out this Model can be used effectively in encouraging and supporting students in Tertiary Education.

In its submission, the Disability Persons Network (DPO) representing the Irish Deaf Society (IDS) and Disabled Women Ireland (DWI) DPOs, noted that '*It is crucial to address the disproportionate impact of classes over quota sizes on students who require additional support, such as those with specific learning differences like dyscalculia. Impairment-related challenges in STEM, including limited hand-eye coordination, must be acknowledged, and accommodated to provide equal opportunities for all students. Proactive universal design and support, rather than relying solely on self-advocacy, are essential for creating inclusive learning environments. Intersectional challenges faced by disabled women and girls in STEM education must be recognised and addressed, while efforts to bridge educational gaps and ensure equal access should be prioritised.'*

In relation to Deaf students several areas must be addressed. Insufficient funding for the development of ISL vocabulary in STEM hinders Deaf students' comprehension and engagement with these subjects. The limited proficiency of teachers in ISL further impedes effective communication and support for Deaf students in STEM education. Resource disparities in Deaf schools restrict the opportunities for Deaf students to pursue their interests in STEM subjects. The lack of response from the Department of Education regarding our proposals underscores the need for transparent communication and prompt action. Furthermore, the absence of accessible online STEM resources in ISL limits Deaf students' ability to engage in self-learning. Finally, we emphasise the importance of consulting Deaf experts and involving DPOs in decision-making processes to ensure that the rights and needs of Deaf individuals are properly addressed.'

RECOMMENDATIONS: FEMALE PARTICIPATION, DIVERSITY AND INCLUSION

33. An *Expert Working Group on STEM Subjects to Increase Female Participation, Diversity and Inclusion* should be established by the Department of Education to review current policy and teaching of these subjects from Primary School up to Senior Cycle. The Group should be chaired by an external expert and comprise teachers, the National Council

for Curriculum and Assessment (NCCA), Subject Matter Experts, industry representatives, disability representatives and senior officials from the Department of Education.

34. The Department of Further and Higher Education, Research, Innovation and Science Education should establish a Consolidated System for the compilation of disaggregate Data Collation and Measurement on the researchers to include gender, disability, ethnic minority and economic status. The data should also record the nature of individual research being undertaken and the proposed outcomes. This data should be used to inform the development of educational policy on an ongoing basis.

35. The Departments of Education and Further and Higher Education, Research, Innovation and Science, in liaison with the relevant Higher Education Institutions (HEI)s, should recruit Disabled, Ethnic Minority and Economically Disadvantaged Students on Initial Teacher Education (BED) and Master of Education (MED) courses that qualify them to teach STEM subjects at Post Primary level. Students would receive bursary’s and be prioritised for student accommodation.

CHAPTER 5 – DIGITAL STRATEGY IN EDUCATION TO SUPPORT STEM

IMPLEMENTATION OF NATIONAL DIGITAL STRATEGY

In her submission, Ms. Norma Foley TD, Minister for Education, pointed out that the STEM Education Policy Statement and the Digital Strategy for Schools are intertwined. She noted that they complement and reinforce each other to encourage broader participation and enhance STEM and digital learning for all learners. She continued '*They acknowledge that in order for this to be achieved, school leaders and teachers require the necessary subject matter knowledge, pedagogical content knowledge and the appropriate skills, confidence and competence to embed STEM and digital skills in learning, teaching and assessment in the classroom.*

It is further acknowledged that schools must continually evolve, improve and learn from best practice in relation to STEM and digital education in order to ensure sufficient skills within the teaching profession to respond to current and future developments. It is recognised in the STEM Education Policy Statement and the Digital Strategy for Schools that the embedding of STEM and digital skills across the school system requires the provision of necessary professional supports and opportunities for teachers and school leaders such as high quality induction and professional learning, information resources and funding.'

DIGITAL LEARNING AT PRIMARY AND POST PRIMARY LEVEL

IPPN submission made the point that of the aims of the STEM strategy are to be realised, financial supports to schools for ICT and curricula must be reviewed and enhanced and backed up by access by all schools to skilled IT support.

The NAPD submission referred to the fact that new subjects have been introduced into the Leaving Certificate, including Computer Science. However, in many schools the expertise among existing staff members is limited in order to deliver the subject to students.

The NAPD submission emphasised that '*the upskilling of teachers is a significant challenge for schools, along with securing the expertise to manage the infrastructure* *in the schools. The priority for schools is the use of technology to enhance the learning experience for the student. The quality and continuity of that learning are dependent on the reliability of the infrastructure and hardware. Schools are not appropriately resourced to maintain the network infrastructure and different schools manage this in different ways. To ensure the embedding of STEM skills into every aspect of the school system, provision will need to be made for technical support for schools to manage the physical infrastructure.'*

In her submission, Dr Ann Marcus Quinn, Lecturer in Technical Communication and Instructional Design, University of Limerick, highlighted the fact that a growing number of schools require students in first year to have a device in order to carry out classroom tasks in many of their subjects. She noted that tasks requiring a device are also detailed in some of the textbooks used in school. Yet, the Department of Education has not resourced students and teachers by providing the requisite devices.

She recommended that The Department of Education should consider a centralised approach to both the procurement and provision of digital devices and the necessary ICT systems.

EI contented that to deliver on Ireland's STEM Education Policy, it is imperative that all education providers are equipped with adequate infrastructure (including high-speed broadband and appropriate digital technologies/learning tools) that facilitates the delivery of high-quality STEM Education. They recommended that STEM teachers/instructors should be given every opportunity to develop and upskill to ensure all students are exposed to the highest quality learning possible. To facilitate this, STEM education staff at all levels must be provided with continual professional development opportunities, particularly as skills, technology and education practices evolve. As such, it is vital that the Digital Strategy for Schools to 2027 is implemented and progress/targets are constantly reviewed to ensure relevance.

The EGFSN noted that the development of the longer-term pipeline for digital skills is being addressed through commitments under the *Digital Strategy for Schools,* such as digital literacy and computer science programmes at primary and secondary level, and technology enhanced learning strategies across FET and Higher Education.

It stated that implementation and realisation of the ambitions in the *STEM Education Policy Statement*- in particular around female participation- and the broader rollout and resourcing of the Computer Science Leaving Certificate programme can play a key role in fostering the ICT Skills pipeline. This should include the better resourcing of girls' schools to facilitate STEM and Computer Science provision.

It warned that the expansion of STEM provision, however, could be frustrated by difficulties in recruitment of a pool of specialist teachers for STEM and computer science.

The TUD Submission recommended the provision of funding to support the acquisition of Virtual Reality and Augmented Reality equipment by primary and secondary schools to support STEM education and to equalise the exposure of all students to its practical aspects.

Dr Cornelia Connolly stressed that in order to enhance Ireland's skills and competences for the digital era, opportunities to learn basic digital skills must be provided from an early age. These include computing education, along with comprehensive knowledge and understanding of data-intensive technologies, such as Artificial Intelligence (AI). The submission noted that Computer Science (CS) curricula are being introduced in education systems throughout the world, offering young people the opportunity to move away from being passive users of computers to becoming designers and to developing a deep understanding of how technology works.

It further noted that while young people are often assumed to be 'digital natives' who can pick up computer skills with ease, her research indicates this is not the case. She reported that '*While students have a high level of access to smart technologies, teachers report that their technical use and understanding of computers is much lower, with students struggling to even turn on a computer or use a mouse. To address this, teachers say that digital education needs to be introduced at an earlier age. The research also raises questions in relation to equity of access, with male-female ratio of 78:22 among students who studied CS for Leaving Certificate in 2022.*'

Finally, it proposed that CS needs to be integrated across all levels in the formal education system. Dr Connolly proposed that '*we need to articulate and implement a strategy for the integration of CS through the continuum from primary school to Senior Cycle. We need to make space in the curriculum to include foundational CS concepts in order to develop these key skills and provide the resources to develop a curriculum that prepares students fully for the digital future.'*

Mr. John Irwin, referring to the teaching of Computer Science, commented '*That might be because they were teaching maths or some of the technological subjects and then took an interest in computer science and brought it in and developed it within the school. Again, it is a bit like the courses that have been run in Limerick for upskilling people in mathematics and so on. It is to upskill people who are currently in the system, as that is often a better mechanism. Now it is on the curriculum we will possibly see undergraduates begin to come through into the educational sphere.'*

Ms Caitlin Faye Maniti spoke about the need for additional resources '*the lack of resourcing and funding, newer, smaller subjects such as computer science need to become more mainstream. To do this, we need the infrastructure and teacher supply. Computers and coding are popular among students as hobbies, but to properly support leaving certificate computer science and junior cycle coding, we must look at the bigger picture. To put it simply, we do not have enough teachers available. Students can enter a plethora of different computer science-related competitions from the BT Young Scientist and Technology Exhibition to SciFest to VEX Robotics. However, the majority of students will not get an opportunity to study computer science as a subject because it will not be offered at their school. The ISSU recommends that there be an increase of investments in facilities for carrying out these STEM subjects'.* Her arguments were echoed by other witnesses and in written submissions.'

Dr Connolly noted that '*In recent years, the Irish education system has embraced CS by bringing it into the curriculum. Nevertheless, we are a long way off making this important subject available to all students. Equity of access is a matter of concern. Currently, CS at senior cycle is limited by the low number of post-primary* *schools offering coding at junior cycle and by a significant shortage of teachers qualified to teach the subject. The capacity of the Irish education system to facilitate CS education is highly contested, with constraints being placed on school timetables. Coupled with this is the low level of awareness and a pervading misunderstanding of what the discipline is and what it is not.'*

Dr Ann Marcus Quinn referred to the provision of digital devices for students and proposed that '…*changing the current systems to improve the value of these purchases for both teachers and students at post-primary level is critical if equity of the digital experience is to be achieved. The Department should consider a centralised approach to both the procurement and provision of digital devices and the necessary ICT systems in order to support well-informed digital school policies and investments. The Department should also provide a recommendation regarding a common minimum standard for both student and teacher devices. A circular was published in 2017 providing recommendations on uniform purchases. A similar approach is necessary for the purchase of technology and associated services until a centralised approach and formal tendering process can be devised.'*

DIGITAL LEARNING AT TERTIARY LEVEL

The EGFSN advised that Further Education and Training (FET), Higher Education and lifelong learning response, should build on the three ICT Skills Action Plans since 2012. In particular, the close cooperation between Government, industry and the education and training sector, in order to attract a pipeline of new entrants into ICT programmes, maximise the capacity and investment in education and training in this area, and provide the upskilling pathways that ensure Ireland's pool of ICT professionals can keep pace with technological trends.

In oral evidence, on 25 April 2023, Mr. Paddy Howard, Principal Officer, DFHERIS, referred to digital skill and dimension 3 of the national digital strategy that sets out the importance of focusing Ireland's skills policy on getting digital skills at every level, including high-level digital skills, digital skills for the labour market and digital skills for society. He stated that this focus is vital so that Ireland can be an international leader in the digital economy. He noted that the Department has underpinned the national digital strategy by setting two overall targets. The first of these is to increase the number of learners who graduate with higher level digital skills to more than 12,400 graduates, apprentices and trainees. The second target is to increase the share of adults 26 JEFHERIS in Ireland with at least basic digital skills to 80%.

RECOMMENDATIONS: DIGITAL STRATEGY IN EDUCATION TO SUPPORT STEM

36. The Department of Education should publish an Action Plan to implement the Digital Strategy for Schools to 2027 by Q4 2023.

37. The Department of Education should develop *A National Online Learning Programme*, to be rolled out to all primary and secondary schools, as a matter of urgent priority, to include:
    - One centralised Learning Platform.
    - Appropriate support and training for all principals and teachers and parents who are home schooling.
    - Remote device purchase that ensures disadvantaged students have access to devices for online learning.
    - Adequate broadband for online learning.
    - Provisions for Blended Learning, and
    - Transition Measures for Schools as the Plan is rolled out.

38. Senior Cycle students should be allowed complete their Senior Cycle examinations and assignments on a computer or other appropriate digital device from 2024 onwards.

39. Digital literacy classes should be introduced from Junior Cycle onwards from September 2024 to ensure all students are digitally literate. Teachers should be provided with training in this area as part of their Continuous Professional Development (CPD) with financial allowances for teaching Digital Skills.

APPENDIX 1: LIST OF SUBMISSIONS

Written submissions were received from the following organisations and individuals.

1. Airfield Estate
2. AMBER, Science Foundation Ireland (SFI) Research Centre for Advanced Materials and BioEngineering Research
3. An Chomhairle um Oideachas Gaeltachta & Gaelscolaíochta (COGG)
4. AONTAS
5. Association of Community & Comprehensive Schools (ACCS)
6. Association of Secondary Teachers Ireland (ASTI)
7. Department of Education
8. Department of Further and Higher Education, Research, Innovation and Science
9. Disability Person's Network (DPO)
10. Dr Áine Hyland, Emeritus Professor of Education, University College Cork (UCC)
11. Dr Ann Marcus-Quinn, Lecturer in Technical Communication and Instructional Design, University of Limerick (UL)
12. Dr Cornelia Connolly, Associate Professor, School of Education, College of Arts, Social Sciences & Celtic Studies, University of Galway
13. Dr Margaret Leahy, Head of the School of STEM Education, Innovation & Global Studies, and Professor Hamsa Venkat, Professor of STEM Education for Primary and Early Childhood Education, Institute of Education, Dublin City University (DCU)
14. Dr Sarah McCormack, Professor of Environmental Engineering, Department of Civil, Structural and Environmental Engineering, Trinity College Dublin
15. Education and Training Boards Ireland (ETBI)
16. Engineering Technology Teachers Association (ETTA)
17. Enterprise Ireland (EI)
18. Expert Group on Future Skills Needs (EGFSN)
19. Higher Education Authority (HEA)
20. Higher Education Colleges Association (HECA)
21. Independent Living Movement Ireland (ILMI)
22. Industrial Development Authority (IDA)
23. Institute of Physics (IOP)

24. Irish Business and Economic Confederation (IBEC)
25. Irish Congress of Trade Unions (ICTU)
26. Irish Federation of University Teachers (IFUT)
27. Irish Mathematics Teachers' Association (IMTA)
28. Irish National Teachers Organisation (INTO)
29. Irish Primary Principals Network (IPPN)
30. Irish Research Council (IRC)
31. Irish Science Teachers Association (ISTA)
32. Irish Second Level Students Union (ISSU)
33. Irish Small and Medium Enterprises (ISME)
34. Irish Universities Association (IUA)
35. Joint Managerial Body (JMB)
36. National Adult Literacy Agency (NALA)
37. National Apprenticeship Office (NAO)
38. National Association of Principals and Deputy Principals (NAPD)
39. National Children's Science Centre (NCSC)
40. National Council for Curriculum and Assessment (NCCA)
41. National Parents Council Primary (NPC)
42. Professional Development Service for Teachers (PDST)
43. Quality & Qualifications Ireland (QQI)
44. Science Foundation Ireland (SFI)
45. Shane O'Connor and Liam Carew, Young Scientists of the Year, Abbey School, Tipperary
46. SIPTU
47. SOLAS
48. State Examinations Commission (SEC)
49. Teachers Union of Ireland (TUI)
50. Technological Higher Education Authority (THEA)
51. Technological University Dublin (TUD)
52. Union of Students Ireland (USI)

APPENDIX 2: ENGAGEMENT WITH STAKEHOLDERS

On 28 February 2023, the Committee held a roundtable discussion with Association of Community & Comprehensive Schools (ACCS); Joint Managerial Body (JMB); National Association of Board of Management in Special Education (NABMSE); and Education and Training Boards Ireland (ETBI)

The debate can be accessed here

On 7 March 2023, the Committee held roundtable discussions with National Association of Principals and Deputy Principals (NAPD); Union of Students Ireland (USI); Irish Second Level Students Union (ISSU); Association of Secondary Teachers Ireland (ASTI); Irish National Teachers Organisation (INTO); Teachers Union of Ireland (TUI) and the Irish Federation of University Teachers (IFUT)

The debate can be accessed here

On 21 March 2023, the Committee held roundtable discussions with Irish Science Teachers Association, (ISTA); Irish Maths Teachers' Association (IMTA); Engineering Technology Teachers Association (ETTA); Irish Universities Association (IUA); Technological Higher Education Authority (THEA) and the Higher Education Colleges Association (HECA).

The debate can be accessed here

On 28 March 2023, the Committee held roundtable discussions with Science Foundation Ireland (SFI); Irish Research Council (IRC); Institute of Physics (IOP) Economic and Social Research Institute (ESRI); Industrial Development Authority (IDA); Enterprise Ireland; Irish Business and Economic Confederation (IBEC) and Irish Small and Medium Enterprises (ISME)

The debate can be accessed here

On 18 April 2023, the Committee held roundtable discussions with Dr Cornelia Connolly, Associate Professor, School of Education, College of Arts, Social Sciences & Celtic Studies, University of Galway; Dr Ann Marcus-Quinn, Lecturer in Technical Communication and Instructional Design, University of Limerick (UL); Dr ÁINE Hyland, Emeritus Professor of Education, University College Cork (UCC); Dr Sarah McCormack, Professor of Environmental Engineering, Department of Civil, Structural and Environmental Engineering, Trinity College Dublin; Dr Margaret Leahy, Head of the School of STEM Education, Innovation & Global Studies and Professor Hamsa Venkat, Professor of STEM Education for Primary and Early Childhood Education, Institute of Education, Dublin City University (DCU); Mr Shane O'Connor and Mr Liam Carew, 2023 Young Scientists of the Year and Mr Jamie Bermingham and Mr Martin Scattergood, World Skills Award Winners

The debate can be accessed here

On 25 April 2023, the Committee held roundtable discussions with Department of Education Officials, National Council for Curriculum and Assessment (NCCA); State Examinations Commission (SEC); Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) Officials, Higher Education Authority (HEA); SOLAS; the National Apprenticeship Office (NAO) and Quality & Qualifications Ireland (QQI)

The debate can be accessed here

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Submission List

Document No.	Date Received	Received From	Brief Description
2023/026	16/02/2023	**Irish Primary Principals Network (IPPN)**	Submission on the Future of STEM in Irish Education
2023/030	22/02/2023	**Higher Education Authority (HEA)**	Submission on the Future of STEM in Irish Education
2023/031 & 031(i)	23/02/2023	**Education and Training Boards Ireland**	Submission on the Future of STEM in Irish Education
2023/033 & 033(i)	24/02/2023	**National Association of Principals and Deputies (NAPD)**	Submission on the Future of STEM in Irish Education
2023/034 & 034(i)	26/02/2023	**Irish Science Teachers Association (ISTA)**	Submission on the Future of STEM in Irish Education
2023/035	27/02/2023	**Irish Mathematics Teachers Association**	Submission on the Future of STEM in Irish Education
2023/036 & 036(i)	26/02/2023	**Áine Hyland, Emeritus Professor of Education, University College, Cork.**	Submission on the Future of STEM in Irish Education
2023/037	27/02/2023	**Dr Ann Marcus-Quinn Lecturer in Technical Communication, University of Limerick**	Submission on the Future of STEM in Irish Education
2023/038	27/02/2023	**Enterprise Ireland**	Submission on the Future of STEM in Irish Education
2023/039 & 039(i)	27/02/2023	**Science Foundation Ireland (SFI)**	Submission on the Future of STEM in Irish Education
2023/040 &(040i& 040(i, ii, iii)	27/02/2023	**National Parents' Council Primary**	Submission on the Future of STEM in Irish Education
2023/041	27/02/2023	**Irish National Teachers' Organisation (INTO)**	Submission on the Future of STEM in Irish Education
2023/042 & 042(i)	27/02/2023	**Ms Norma Foley TD, Minister for Education**	Submission on the Future of STEM in Irish Education
2023/043 & 043(i)	27/02/2023	**Aontas**	Submission on the Future of STEM in Irish Education
2023/044	27/02/2023	**Dr Cornelia Connolly, Associate Professor, University of Galway**	Submission on the Future of STEM in Irish Education
2023/045	27/02/2023	**Engineering Technology Teachers Association (ETTA)**	Submission on the Future of STEM in Irish Education
2023/046 & 046(i)	27/02/2023	**National Adult Literacy Agency (NALA)**	Submission on the Future of STEM in Irish Education
2023/047	27/02/2023	**Irish Federation of University Teachers (IFUT)**	Submission on the Future of STEM in Irish Education
2023/048	27/02/2023	**Dr Margaret Leahy and Professor Hamsa Venkat, Institute of Education, Dublin City University (DCU)**	Submission on the Future of STEM in Irish Education

2023/049 & 049(i)	**27/02/2023**	**Institute of Physics**	Submission on the Future of STEM in Irish Education & Institute of Physics briefing note in advance of the Roundtable discussion on the future of STEM in Irish Education, on 28 March 2023.
2023/050 & 050(i)	**27/02/2023**	**National Apprenticeship Office**	Submission on the Future of STEM in Irish Education
2023/051	**27/02/2023**	**National Council for Curriculum and Assessment (NCCA)**	Submission on the Future of STEM in Irish Education
2023/053	**28/02/2023**	**Irish Universities Association (IUA)**	Submission on the Future of STEM in Irish Education
2023/057	**03/02/2023**	**Irish Second Level Students' Union (ISSU)**	Submission on the Future of STEM in Irish Education
2023/060	**03/03/2023**	**Teachers' Union of Ireland (TUI)**	Submission on the Future of STEM in Irish Education
2023/067	**07/03/2023**	**Higher Education Colleges Association (HECA)**	Submission on the Future of STEM in Irish Education
2023/076 & 076(i)	**10/03/2023**	**Department of Further and Higher Education, Research, Innovation and Science**	Submission on the Future of STEM in Irish Education
2023/091	**24/03/2023**	**Airfield Estate**	Submission on the Future of STEM in Irish Education
2023/100	**30/03/2023**	**An Chomhairle um Oideachas Gaeltachta & Gaelscolaíochta (COGG)**	Submission on the Future of STEM in Irish Education
2023/102	**03/04/2023**	**AMBER, SFI Research Centre for Advanced Materials and BioEngineering Research Trinity College, University of Dublin**	Submission on the Future of STEM in Irish Education
2023/112	**06/04/2023**	**Expert Group on Future Skills Needs (EGFSN)**	Submission on the Future of STEM in Irish Education
2023/165	**24/05/2023**	**Technological University Dublin (TUD)**	Submission on the Future of STEM in Irish Education
2023/196	**29/06/2023**	**Independent Living Movement Ireland (ILMI)**	Submission on the Future of STEM in Irish Education
2023/197	**29/06/2023**	**Disabled Person's Organisations (DPO) Network**	Submission on the Future of STEM in Irish Education

2023/026

The Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

Submission by the Irish Primary Principals' Network

Prepared for:

The Joint Committee on Education,

Further and Higher Education, Research,

Innovation and Science

Prepared By:

Irish Primary Principals' Network

February 2023

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Introduction

IPPN is the officially-recognised professional body for the leaders of Irish primary schools. It is an independent, not-for-profit voluntary association with a local, regional and national presence. Recognised by the Minister for Education as an official Education Partner, IPPN works with the Department of Education, the National Parents' Council, the Ombudsman for Children, management bodies, unions, education agencies, academic institutions and children's charities towards the advancement of primary education. IPPN articulates the collective knowledge and professional experience of over 6,000 Principals and Deputy Principals.

This submission captures a number of key points relating to STEM education, as well as the issues and concerns of primary school leaders in relation to the sustainability of their role in system change. We would be happy to answer any questions the Committee may have.

Sustainable Leadership

It is important to note that any strategy that affects primary schools – whether related to child protection, literacy and numeracy, elements of the curriculum such as STEM, or bullying prevention - will largely be the responsibility of the school principal as the leader of learning in their school, supported by the Leadership & Management team, where such a team exists, and a voluntary Board of Management.

It is fair to say that the importance of school leadership as an influence on and key determinant of pupil learning has been clearly and irrefutably established. Put simply, effective school leadership leads to school effectiveness which, in turn, leads to better outcomes for children. It is therefore essential that school leaders should be empowered and supported to deliver that effective leadership in our schools, and facilitated to maintain their focus on their core purpose – leading teaching and learning. Anything that negatively impinges on or detracts from the potential effectiveness of school leaders has a detrimental impact on schools and, more importantly, on learners and must be addressed.

There is a largely unaddressed crisis relating to the sustainability of school leadership in Irish primary schools. In order to understand the extent, causes and impact of this crisis, IPPN explored how leadership is practised and experienced in our primary schools, informed by the data we garnered from our member survey, to which over 1,000 school leaders responded.

We asked those school leaders to rate the current sustainability of their leadership role (0 being totally unsustainable and 10 being fully sustainable). Their responses tell us that:

- school leaders rate the level of sustainability of their leadership roles at just less than 4 (3.96)
- principals of **DEIS schools** rate the level of sustainability of their leadership roles at just 3.76
- **teaching principals** rate the level of sustainability of their leadership roles at just 3.53
- 26.3% of school leaders rated the sustainability of their leadership role at 0, 1 or 2.

In order to develop a deeper understanding of why school leaders experience their roles as unsustainable, we explored the context in which school leadership is practised in Ireland, which is characterised by:

- a lack of role clarity
- increasing role complexity
- the breadth of responsibilities
- inadequate infrastructural supports and
- the workload that arises from all of the above.

In order to ensure school leadership of the highest quality in our schools, and a leadership role that is sustainable and less likely to have a negative impact on the health and wellbeing of school leaders, consideration needs to be given to the following:

- the development of a shared understanding of what constitutes effective school leadership and the core purpose of that leadership
- the extent to which school leaders are deflected from their core purpose by having to take on responsibilities and tasks not related to that purpose and how that impacts on the sustainability of their roles
- the skills, knowledge and competencies school leaders require to enable them to be effective
- whether there is a need for a systematic process of preparation for leadership and what it might look like
- whether the process by which school leaders are recruited could be improved
- whether all school leaders are afforded sufficient time and space to exercise both the leadership and management dimensions to their roles
- how leadership can be shared and supported more effectively in schools

- how the current governance structure in primary schools is impacting on the sustainability of school leadership roles and how that structure could be reimagined.

IPPN's publication ***Primary School Leadership: The Case for Urgent Action - A Roadmap to Sustainability*** can be accessed by clicking here.

General Points re. STEM Education

IPPN fully supports equitable access to STEM education for all children and welcomes the focus on integration across primary and post-primary sectors. If STEM is to be encouraged at both primary and post-primary levels, the foundations must be set at primary level, and the appropriate investment made.

Adequate resourcing and training need to be provided to enable primary schools to effectively embed STEM learning at an early age. Indeed, research has shown that if children, particularly girls, do not have an appreciation for STEM by the time they leave primary education, they are far less likely to take up STEM subjects at second level.

There is widespread agreement in primary education that, while STEM subjects are valuable, there should not be undue emphasis on them at the expense of other aspects of education, especially the Arts. Many other developed countries have adapted STEM to include the arts, known as 'STEAM'. There is an opportunity for the Department of Education and the NCCA to integrate the curricula to cover all of STEAM.

With the imminent launch of the new Primary Curriculum, there is an opportunity to further promote and develop the 'softer skills' – particularly communication and interpersonal skills - and pupils' creativity within the curriculum, alongside enhanced STEM education. These life skills are crucial to any organisation, including those in the technology industry. It also affords the opportunity to integrate the Department's ICT Strategy and investment in ICT with the STEM Strategy and a commitment to provide ongoing and adequate funding for both.

Teacher CPD

If a full appreciation of STEM subjects is to be realised at primary level, it must be recognised that the vast majority of teachers require significantly more training and ongoing professional development in what would be expected of them. Furthermore, in order to focus on STEM, all schools must have adequate Broadband access. Despite the roll-out of broadband infrastructure in recent years, this is still not the case in a significant number of primary schools in 2023 and must be achieved before any expectations are levelled on schools to enhance STEM teaching and learning.

Other barriers to teacher CPD need to also be addressed. For example, approved courses in STEM undertaken during the school year should qualify for EPV days. This would act as an incentive to teachers to undertake CPD and help them to put their learning to immediate use.

The education system must be careful not to embrace the 'Hero/Champion' teacher model as it tends to be short-lived when the 'heroes' go to pastures new. If STEM and STEM approaches are to become embedded in primary education, then every teacher needs to be a 'STEM teacher'. It may be worth exploring the identification of specific schools with strong STEM teaching approaches in different geographical areas and build clusters around them, through facilitated CPD. This might involve drawing on schools already proficient in STEM or asking schools to upskill in STEM with DE support. These schools could then be the 'magnet' or 'beacon' schools with a specific task of having planned interaction with the schools in their cluster. Additional teacher/teachers and equipment would be required to facilitate such an approach.

Optional placements are a good, if limited, idea. Industry talks a lot about STEM in education but businesses often tend to engage with primary schools at a very superficial level. There is also a danger of building further inequality into the system from a geographical perspective as technology companies operate in larger urban areas. Financial support from industry for STEM training/ programmes that would be available to all schools might be more equitable and effective.

ICT Resources and STEM

As noted above, ongoing and adequate support for ICT and related expenditure must be provided to all schools equitably. Individual grants do not provide adequately for installation, upgrade and maintenance of hardware, software and networking, nor for technical support in primary schools. Many schools are left to fundraise or seek local sponsorship to cover the cost of these essential requisites. This heightens inequity across schools, as those in better-off areas are far more likely to access such income streams than those in economically deprived areas.

STEM resources, outside of ICT equipment, are also expensive. All schools must be provided with regular finance to purchase science, engineering and maths equipment. An efficient approach to achieving this may be to adequately resource all the Education Centres, facilitating a system of sharing among schools.

In essence, if the aims of the STEM strategy are to be realised, financial supports to schools for ICT and curricula must be reviewed and enhanced, and backed up by access by all schools to skilled IT support.

Gender Equity and the Promotion of STEM

The biggest challenge to the promotion of STEM is the simplest one. If children – both girls and boys - are exposed to interesting, well thought-out, well-planned STEM lessons that build on their previous work, then they will be more interested in taking these subjects at second level. Research shows that, where interest is not developed by the end of primary, children do not take these subjects later.

In Conclusion

The key advantages of the primary curriculum must be maintained, particularly the focus on the holistic development of the child, rather than a narrow focus on subjects and skills. Creativity across a wide range of skills needs to be harnessed and nurtured. This can and should include STEM learning but not at the expense of other learning opportunities. Schools are developing children to become well-balanced individuals with the capacity for life-long learning and to contribute to society as a whole, not just to the workplace, and this needs to be borne in mind in any DE strategy. It will be crucial to ensure that there is adequate investment in professional development for all teachers, as well as curriculum resources, ICT infrastructure and resources, if the new curriculum, including STEM education, is to succeed.

HEA | HIGHER EDUCATION AUTHORITY
AN tÚDARÁS um ARD-OIDEACHAS

Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

1. Introduction

In Ireland, 30% of students entering higher education for the first time study STEM. This translates to more than 20,000 STEM graduates in Ireland annually. The National Skills Strategy[1] identifies a need to increase STEM participation, and in particular, female participation in STEM. To foster engagement with STEM, the National Strategy for Higher Education[2] emphasises the importance of access and induction. Developing talent and skills required for the future of work is pivotal to addressing key challenges, such as climate research and innovation, as evident in the Climate Action Plan[3]. The Housing for All Plan[4] also identifies a need for more education and training opportunities, including apprenticeships and newly developed courses. In 2022, nearly 8,300 new apprentices were registered, with 82% of these being STEM-related apprenticeships.

2. Evidence on the Future of STEM

2.1 STEM in Tertiary Education

2.1.1. Outlook. Over the past five years, certain STEM disciplines have seen larger increases than others. Electricity and Energy has seen the largest increase in the number of new entrants, up by 57%. This is followed by Architecture and Construction, up 55%, Mathematics, up 54%, and Environmental Sciences, up 53%.

2.1.2. Non-Progression. STEM students are less likely to progress from first year to second year, compared to non-STEM students. In the latest year, 11% of STEM students did not progress to second year, compared to 8% of non-STEM students. Males are also less likely to progress than females, particularly male STEM students. At NFQ Levels 6 and 7, the non-progression gap is much larger. At Level 6, 26% of STEM students do not progress, compared to 13% of non-STEM students. At Level 7, this gap reduces to 5-percentage points, and at Level 8, this gap reduces to 1-percentage point.

[1] https://www.gov.ie/en/publication/69fd2-irelands-national-skills-strategy-2025-irelands-future/
[2] https://www.gov.ie/en/publication/072a65-national-strategy-for-higher-education-to-2030/
[3] https://www.gov.ie/en/publication/7bd8c-climate-action-plan-2023/
[4] https://www.gov.ie/en/publication/ef5ec-housing-for-all-a-new-housing-plan-for-ireland/

2.1.3. Graduates. Annually, Ireland produces more than 20,000 STEM graduates. Nine months after graduation, 3 in 4 Undergraduate Honours Degree STEM graduates are in employment, with 94% of these graduates staying in Ireland for employment. Importantly, 84% consider their qualification necessary for their current position.

2.1.4. Research Funding. The Irish Research Council supports a range of STEM education initiatives. The IRC currently has a total investment of €677,000 in STEM education projects. These supports fall under the Government of Ireland Postgraduate Scholarship Programme, the Employment-Based Postgraduate Programme, the COALESCE scheme, and the New Foundations Scheme.

2.1.5. HCI Pillar 3. The Human Capital Initiative Pillar 3 projects aim to develop initiatives in higher education institutions working with enterprise that are innovative and agile. These projects are five years in duration and overall, 24 projects have been funded, with 10 of these having a heavy focus on STEM. These include – (i) Cyber Skills, providing courses created by industry and academia with content informed by the needs of the workplace to enhance the skills of networking and software development professionals, (ii) UL@Work, consisting of more than 19 flexible programmes for undergraduate, graduate and work-based learners designed to meet the needs of working professionals, employers and industry, in areas such as Data Analytics, Cybersecurity, Cognitive Robotics, and Engineering, (iii) the iEd Hub focusing on the development of joint programmes with input from Life Science & MedTech enterprises that equip graduates with technical, interpersonal and lifelong learning skills, (iv) the Advance Centre offering a range of modules and courses in the digital transformation arena to address skill gaps that are emerging due to the tech and digital transformations taking place across industry in Ireland. Courses include Cybersecurity, Data Science, Digital Agriculture, Data Analytics for Health, and Digital Manufacturing.

2.2 Female Participation in STEM

2.2.1. Overview. Overall, 30% of students entering higher education for the first time studies STEM. Nonetheless, a large gender gap is evident. While 43% of men study STEM, 19% of women study STEM, representing a 24-percentage point difference.

2.2.2. ICT Summer Camps. In 2021, the HEA allocated €376,000 to support further provision of ICT Summer Camps. These camps encourage students to consider a career in ICT and computing, and are geared towards second-level students, with a focus on female participation, and students from DEIS schools. More than 2,600 students participated, and female participation was 47%.

2.2.3. Gender Equality Enhancement Fund. In 2022, the HEA awarded more than €246,000 to advance gender equality initiatives under the Gender Equality Enhancement Fund. These were awarded across three areas – (i) research on or advancing gender equality initiatives in Ireland, (ii) training programmes specifically addressing gender equality, and (iii) Athena SWAN capacity-building activities. These efforts include STEM-related initiatives, such as the INDICATOR project, investigating the gender dimension in computing research across the Irish HEI sector.

2.2.4. Research Policies. Since the publication of the Irish Research Council's Gender Strategy and Action Plan in 2013, the IRC has committed to gender balance in assessment panels, and to gender-blind assessment to mitigate any gender bias in assessment. These measures have had a positive impact on gender equality in research and led to greater awareness and integration of the sex / gender dimension in research content. In November 2021, the IRC published a Policy on Leave for Parents and Carers. This includes maternity, paternity, adoptive, parent's, parental and carer leave[5]. The IRC also introduced its Policy on Bullying, Harassment and Sexual Harassment in June 2021[6]. A vital component of this policy is that IRC awardees can change institution and / or supervisor without penalty if the circumstances of their environment become untenable. The recently revised *HEA Principles of Good Practice in Research within HEIs*[7] set out the HEA's nine elements of good research practice to incorporate into their research environments. This includes areas such as 'Gender Equality and Inclusiveness' and 'Research and Sustainability'; all principles are in line with current international best practice.

2.3 Diversity and Inclusion in STEM

2.3.1. National Access Plan. The National Access Plan – A Strategic Action Plan for Equity of Access, Participation and Success in Higher Education 2022-2028 was published in August 2022 and is based on two overarching ambitions – (i) that the higher education study body entering, participating in, and completing higher education, at all levels reflects the diversity and social mix of Ireland's population, and (ii) that our higher education institutions are inclusive, universally designed environments which support and foster student success and outcomes, equity and diversity and is responsive to the needs of students and wider communities. Under

[5] https://research.ie/assets/uploads/2017/05/IRC-Policy-on-Leave-for-Parents-and-Carers_April-2022.pdf
[6] https://research.ie/assets/uploads/2021/06/IRC-Bullying-Harassment-and-Sexual_Harassment-Policy_June-2021.pdf
[7] https://hea.ie/2022/12/16/hea-principles-of-good-practice-in-research-2022/

the inclusivity goal in the plan is an objective to consider how to achieve a more diverse student population across all programmes and all levels of study, both undergraduate and postgraduate. This is relevant for STEM with data in the Plan showing that, for example, just 4.9% of new entrants doing Mathematics in 2019/20 were from disadvantaged areas compared to 19.1% from affluent areas. Over the lifetime of the National Access Plan, a range of key performance indicators will be monitored to assess progress, trends, and diversity across STEM fields of study.

2.3.2. Upskilling and Reskilling Initiatives. Springboard+ and the Human Capital Initiative (HCI) Pillar 1 offer free and heavily subsided courses in areas of high demand, such as ICT, engineering, green skills, data analytics, and construction. These initiatives aim to support the skills of those in employment, and to build the supply of skilled graduates to meet the current and future skill needs of the Irish economy. A primary focus for these initiatives is to support those who are unemployed and wish to return to the workforce.

2.3.3. NTUTORR. The National Technological University Transformation for Recovery and Resilience project is designed to transform learning, teaching and assessment, with a particular focus on equality, diversity, and inclusion. This consists of various work packages supporting diversity and inclusion through the use of digital technologies across the technological sector – examples include (i) HyFlex AccessHE Foundation Programme empowering prospective students with digital capabilities, and confidence to enter and succeed in HE, (ii) the HyFlex Student Support Programme, leveraging digital technologies to promote student success for a diverse student body in more flexible and accessible ways that enhance and extend existing supports, and (iii) Sustainable Learning and Pedagogical Environment, using digital infrastructure that ensures diversity, equity, and inclusiveness in the areas of examination, assessment, academic integrity and research ethics.

2.4 *Digital Strategies to Support STEM*

2.4.1. Open Courses for Professional Development. In collaboration with the National Forum for the Enhancement of Teaching & Learning, these courses have been developed for higher education educators in Ireland. These courses empower teachers with digital skills, enabling them to harness the power of technology for learning impact.

2.4.2. NTUTORR. This consists of various work packages supporting digital enhancement of teaching and learning across the technological sector. Examples include (i) the Digital Literacy and Citizenship Student Competency Framework, and (ii) the TU Student Digital Backpack, providing flexible, accessible, self-directed learning pathways to empower students to learn and develop skills focused on global priorities and challenges.

2.4.3. HEI-led Initiatives. EPISTEM, run by University of Limerick, delivered tailored online CPD courses for post-primary maths teachers. ATU Donegal targeted the provision of data science support for the FinTech regional cluster in the Northwest cross-border region through the development of a new Data Science Research Centre, including funded Research Masters and projects partnering researchers and industry. Under the COALESCE scheme 2021, UCD received IRC funding for the ARITHMÓS Project, transforming children's maths education through digital games.

2.4.4. HCI Pillar 3. Virtual Labs, a project funded by HCI Pillar 3, focuses on the use of virtual laboratories as a teaching tool for the chemical sciences. The Digital Academy for Sustainable Built Environment is another project funded by HCI Pillar 3, and focuses on upskilling, capacity building and education in the construction sector.

3. Recommendations for Action

- To continue to support initiatives and programmes that drive STEM engagement, upskilling and lifelong learning, and responsivity to future challenges.
- Promote diversity and inclusion in the development of any such initiatives and programmes, ensuring representation, and equal access.
- Leveraging digital capabilities to foster an inclusive environment, that is accessible for all, and further empowering learners.
- Develop innovations and design systems and environments that are fit for all, to maximise accessibility, usability, and inclusion.
- Pilot and share learnings – with a growing evidence base, learnings can be shared and applied to other areas, e.g., primary / post-primary.

4. Summary

STEM can ignite change and transformation. The future of STEM will give rise to new innovations to tackle the world's most pressing problems. Upskilling and lifelong learning are imperative – to ensure that our society is responsive to labour market needs, and to any future challenges that may arise. Moreover, to ensure no one is left behind. Promoting female participation in STEM, diversity and inclusion are fundamental, to establish and develop innovative solutions that are representative and fit-for-all. Digital strategies can support this mission, to bolster access to education for all. The future of STEM will continue to empower learners to shape the future, and tackle tomorrow's problems.

etbi
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Boird Oideachais & Oiliúna Éireann

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Education and Training Boards Ireland (ETBI) submission to the
Joint Committee on Education, Further and Higher Education, Research, Innovation and Science on
"The Future of Science, Technology, Engineering and Maths (STEM) in Irish Education".
27th February 2023

1. Introduction

Education and Training Boards Ireland (ETBI) welcomes the invitation by the Joint Oireachtas Committee on Education, Further and Higher Education, Research, Innovation and Science to contribute to the Committee's examination on *"The Future of Science, Technology, Engineering and Maths (STEM) in Irish Education"*. Education and Training Boards Ireland (ETBI) is the national representative body established to collectively represent the sixteen Education and Training Boards (ETBs) and promote their interests. ETBI aims to lead and advance the continued development of education, training and youth work in Ireland by harnessing it's strength to influence and promote a strong education and training sector through collaboration and collective effort. (ETBI, 2022). The work of ETBI is underpinned by its five core values: Excellence, Care, Equality, Community and Respect, which also represent the core values of the ETB sector working collectively. ETBs have responsibility for education and training, youth work and a range of other statutory functions. As of August 2022, ETBs are patrons of twenty-seven Community National Schools (CNS) and one third of all post primary schools in Ireland, as well as a small number of Community Special Schools and Community Hospital Schools. In addition, ETBs provide Further Education and Training (FET) services to over 150,000 learners per year, on a full and part time basis, across all fields of study.

2. Context

Opportunities for children and students in ETB schools to engage in STEM education across primary, special and post-primary schools are increasing because of the variety of policies, structures and supports that have been put in place since the publication of the *STEM Education Policy Statement 2017-2026* (Department of Education, 2016). ETBI would like to acknowledge the significant impact of this overarching policy on subsequent policies, frameworks and curriculum specifications whilst also recognising the range of reforms and initiatives which informed its development. The policy statement's emphasis on collaborative action and commitment to STEM across the education system continues to contribute to the systematic achievement of its objectives and high-level actions. Examples of policies, frameworks and curriculum specifications helping to embed STEM education within primary, special and post-primary schools include, but are not limited to: the *Junior Cycle Framework* (NCCA, 2015), the *Digital Learning Frameworks for Primary and Post-Primary Schools* (Department of Education, 2018); the *Action Plan for Education* (Department of Education, 2019), the *CÉIM Standards for Initial Teacher Education* (Teaching Council, 2020); the Digital Strategy for Schools to 2027 (Department of Education, 2022); *Looking At Our School: A Quality Framework for Primary, Special and Post-Primary Schools* (Inspectorate, 2022). Of particular significance with the policy statement is its recognition of the broad STEM education experience, which includes reference to Further and Higher Education, despite its objective and high-level action focus on early years, primary and post-primary education.
From a Further Education and Training perspective, *Irelands National Skills Strategy 2025* recognises that Ireland is strongly oriented towards knowledge-intensive industries and there will be an increasing demand for people with STEM related skills and qualifications, at a range of levels across different sectors of the economy. The FET Strategy 2020-2024 recognises FET's role in supporting the

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development of these skills to anticipate and respond to these rapidly evolving regional and national needs. It aims to do so by building the digital capabilities now required for most occupations and developing specific Level 4-6 courses targeting growth sectors and occupations like STEM.

3. STEM in ETB Schools

1. Existing Practice in Schools

In line with phase 2 of the implementation of the STEM Education Policy Statement 2017-2026, there is evidence of STEM education being embedded at school level within the ETB sector.

1. Curriculum, Policy and School Self-Evaluation of Ethos

ETB primary schools report engagement in STEM education within discreet areas of the existing 1999 Primary School Curriculum including science, maths and art. Schools also report taking an integrated approach to STEM education through cross-curricular integration, particularly with the arts. From a curriculum policy perspective, schools note their development of whole school plans for maths and science as well as Digital Learning Plans, supported by the Digital Learning Framework for Primary Schools (Department of Education, 2018). From the perspective of evaluation, schools also note their engagement in school self-evaluation (SSE) in STEM areas/disciplines, with particular regard for mathematics.

2. Professional Development and Partnerships

Increased engagement in STEM education at school level is supported through a variety of professional learning opportunities and support materials for teachers. Of particular note is support available from the Professional Development Support Service for Teachers (PDST) STEM Team. Resources from the Science Foundation of Ireland and Primary Science website were also noted of value as were the various Subject Associations or Teacher Professional Networks at post-primary level Schools note the support they have received through partnerships with other schools as well as businesses and industry including Intel, LEGO, the Science Foundation of Ireland, local county councils and libraries. Some schools also report partnerships with schools and universities in Northern Ireland through cross border projects such as Peace IV. In many cases, work experience during Transition Year has a STEM theme supporting the experiences for students.

3. Approaches and Resources for STEM at school level

Schools note the implementation of variety of STEM approaches and resources, including concrete and active learning approaches such as design and make, maths eyes, inquiry learning approaches, science investigations, forensic science projects, school tours, projects. Schools also note the benefits of facilitating initiatives, competitions and awards to promote interest and engagement in STEM. Examples include, but are not limited to, Engineering Week, Maths Week, Science Week, Intel Mini-Scientist, Discover Primary Science, Dreamspace, Science Blast , BT Young Scientist as well as school-based science fairs. Schools are also availing of the increasing availability of resources for STEM including 1:1 devices for children, coding equipment, 3D printers, apps, movie and podcast creation tools and greenscreens. Of particular note for some ETB schools is the availability of Office 365 accounts from their local ETB. From the perspective of inclusivity, schools note the approaches to ensure access to STEM through purchasing school devices for all children or on behalf of families who cannot afford them through the school or other financial schemes.

2. Future of STEM Education

1. Opportunities

- <u>Primary Curriculum Framework:</u> At primary level, ETBI recognises the significant opportunities for both embedding and realising the objectives and high-level actions outlined in the *STEM Education Policy Statement 2017-2026* through the Primary Curriculum Framework

(NCCA, 2023), the publication of which is imminent. This Framework looks set to place a more significant emphasis on STEM through both discreet curriculum areas and subjects as well as across the curriculum through the 7 key competencies, particularly being a digital learner and being mathematical. In particular the move away from separate subject specifications for mathematics and science at junior primary level towards the curriculum area of Mathematics, Science and Technology is significant. The addition of Technology in primary and special schools for the first time is of note. The implementation of these areas and subjects provides a timely opportunity to enhance teacher confidence and competence in all disciplines of STEM through meaningful professional learning experiences.

- Post Primary Curriculum: The impending revision of the senior cycle curriculum is an ideal platform to ensure that greater cross curricular and multi-disciplinary approaches are adopted for all subjects. STEM subjects are not the only place for developing the key skills of critical thinking, problem-solving, analytical skills, creativity and innovation: it's a whole school responsibility. Other subjects in schools can be related to STEM subjects in various ways, and cross curricular approaches to education can help students see the connections between different subjects and their applications. The following are ETBI suggestions for how STEM could become a part or even a significant part of other subjects into the future, particularly in a revised senior cycle model.

The post-primary curricula could adopt a broader subject lens for the teaching of STEM skills:

- Wellbeing: Wellbeing can be related to STEM subjects through the study of brain functions/ anatomy/physiology, as well as the use of technology in sports and fitness
- Social Studies: how technological advances have impacted on society in a social and ethical space (study of History//Geography/CSPE)
- Business, Accounting, Economics: can be related to STEM subjects through the study of entrepreneurship, innovation, and the impact of technology on the economy and professions.
- Arts: creative problem solving and design, as well as the use of technology in artistic expression
- Modern European Languages: reading and writing about scientific, technological, mathematical, and engineering concepts, as well as using language skills to explain, elucidate and communicate STEM concepts and impact.

- Special Schools: Of note within the *STEM Education Policy Statement 2017-2026* is the omission of special schools alongside primary and post-primary schools. Given that under the new primary school curriculum, primary and special schools will for the first time, have a framework underpinning learning, teaching and assessment in their schools, there is a significant opportunity to more formally and explicitly realise the objectives and high-level actions from the policy in special schools.
- Oide: With regards to teacher professional learning, another significant opportunity lies in the integration of the existing support services under Oide. The coincidence of this integration alongside the redevelopment and implementation of a new primary curriculum, Junior Cycle Programme and a revised Senior Cycle provides a significant opportunity to harness the strength and experience of these existing services to embed and fully realise STEM education in primary, post-primary and special schools in Ireland.
- Digital Strategy for Schools to 2027: The upcoming development of the implementation plan for the Digital Strategy to 2027 presents another opportunity for the future of STEM. The effectiveness of this implementation will have significant bearing the embedding of digital technologies in teaching learning and assessment.

2. Challenges

ETB schools note some challenges which need to be overcome to support the successful future of STEM education.

- Funding: Some schools note a lack of resources and funding from the state to fully implement STEM education across the school curriculum. Some mentioned that they have relied on funding from partnerships with industry and businesses to fully develop this area. Despite the recognised benefits of such partnerships, consideration needs to be given to how schools will be appropriately funded and resourced going forward. Some schools have expressed particular concern in this regard because of the observed downsizing of tech companies of late and the impact this could have long-term on the funding of STEM partnerships with schools.
- Training and curriculum/policy overload: Irish education is undergoing a period reform at present. Schools are being challenged by the impact of subsequent curriculum and policy change. Consideration needs to be given to the sustainable and manageable implementation of the Digital Strategy for Schools to 2027, the Primary Curriculum Framework, including curriculum areas such as Mathematics, Science and Technology, Junior Cycle and a revised Senior Cycle. In primary level, schools are already reporting professional development overload and note that areas such as science and technology will be neglected if teachers feel overwhelmed. Release days with substitute cover for teachers to engage in professional development would be welcome, but the current substitute crisis is a major challenge if this is to take place. Children and students thrive with the challenge of STEM education and that teachers need to be encouraged and supported at school level to ensure that pupils receive the best STEM education.

Looking forward: Supporting a STEM mindset in primary and post-primary schools

ETBI recommends that schools begin to look at the potential of STEM through the lens of projects such as SELFIE, an EU project that gathers the views of students, teachers and school leaders on how technology is used in their school, or indeed through the Digital Schools Award. This will assist schools in the development of technologies that support STEM learning.

ETBI recommends providing Principals, Deputy Principals and Teachers with professional development opportunities to improve their STEM instruction, purchasing the latest technology and equipment for STEM classes

ETBI recommends that schools be encouraged to specifically develop partnerships with local businesses and organizations to provide students with real-world STEM experiences: in other words, rather than just work experience, a STEM work experience, or a visit to a primary school classroom from someone working in a STEM environment

Equal Access to STEM: Encouraging girls to study STEM subjects in schools requires a multi-faceted approach that involves role models, mentorship, exposure, hands-on learning opportunities, and curriculum changes. By working to address the gender gap in STEM fields, we can help to ensure that all students have equal opportunities to succeed in these areas: this may require specific interventions.

Links: STEM skills do not begin and end in school settings. More explicit connectivity is required between schools and HE/FE, in order to fully develop the STEM skill set of every student in a cohesive and student-centered manner.

4. STEM in Tertiary Education

Further Education and Training (FET) in Ireland provides STEM education and training services to learners on a full and part time basis, offering certification from Level 1 to 6 on The National Qualifications Framework, delivered in a variety of settings, from large Institutes of Further Education to small community-based facilities. FET STEM most commonly offers programmes which are focussed on clear pathways to skilled and sustainable STEM employment or progression onto HE (Post Leaving Certificate, Apprenticeships and Traineeships at levels 5-6), as well as programmes which are designed to facilitate STEM employment or progression to other STEM education and training opportunities (Youthreach and Back to Education Initiative at levels 3-4). Additionally, FET STEM offers programmes which focus on the development of core STEM skills such as numeracy and digital skills (Adult Literacy, Community Education, ITABE at levels 1-2).

1. Female Participation, Diversity and Inclusion

It is broadly acknowledged that there is equity of participation across FET STEM education, with STEM learners of all socio-economic backgrounds, nationalities, gender and abilities. However, slight variances in gender and ability are evident, depending on STEM provision and geographical region. While it is widely accepted that STEM is a stereotypical male dominant sector, evidently this is not as prevalent in the FET sector. Provision that is focussed on pathways to employment (Post Leaving Certificate, Apprenticeships and Traineeships at levels 5-6), sees a significantly higher percentage of younger males engaged, especially in Engineering disciplines. An exception can be seen in rural Ireland, where the gender imbalance associated with this provision is overturned, potentially due to the accessibility of agriculture careers. At this level, an imbalance of participation based on educational status can be seen, with a high percentage of learners participating having obtained an average Leaving Certificate/QQI L4 certificate or higher. Provision that is designed to facilitate STEM employment or progression to other STEM education opportunities (Youthreach, Community Education, Back to Education Initiative at levels 3-4) see a significantly higher number of STEM learners with additional support needs, at least 50% of those engaged, potentially due to its ethos and availability of supports such as tutor support, LLN, reasonable accommodation, personal assistants, assistive technologies, TEL and one-to-one tuition.

2. FET STEM in Practice

FET STEM provision is a dynamic and progressing field, contributing to testimony of a wide range of effective practices. At levels 3-4, Youthreach Centres have developed and expanded STEM curriculum, through the incorporation of the *Full STEAM Ahead* project; a hands-on, extra-curricular STEAM education model, aligned with QQI modules and LCA, aimed at enhancing links between industries and apprenticeships. This project provides learners with the opportunity to engage with technologies such as 3D printers and virtual reality headsets. PLC settings are forefront in providing STEM specific awards, both major and minor, such as Maths for STEM 5N0556 module at QQI Level 5. Partnership links with HE have also been formed in developing collaborative STEM initiatives such as the creation of pathway courses which allow learners to progress directly to HE and the hiring staff with industry experience to teach STEM subjects. Additional mathematic support is provided to learners engaged in Apprenticeships which include one-to-one support, group tuition and access to a range of industry specific maths resources. Digital infrastructure exists at all levels to support STEM, providing learners with access to computer suites, laptop loaning schemes, Zoom, Microsoft Teams and VLEs. In addition, the FET sector can avail of STEM specific Erasmus programmes, such as 'DIGIBLEND', which was developed to improve adult digital literacy through innovative gamified blended learning.

3. FET STEM Opportunities

It is largely recognised that FET STEM education is a progressing space with the potential of securing extensive opportunities in the future. FET has an opportunity to enhance STEM provision from unaccredited up to Level 6 by providing continued supports and ensuring inclusive practice in provision. In achieving this and in order to develop with modern life and technological advances, a number of actions are required to ensure FET STEM education continues to be the progression route into STEM employment and a clear pathway for those seeking to progress into Further and Higher Education, namely:

4.3.1 Investment in technology

A significant challenge for FET STEM is the lack of a Digital Strategy specifically designed to support STEM education. In addition, the sector is concerned that its equipment is out-of-date and more investment is required, particularly in resources specifically designed for STEM education. Investment in technology and equipment associated with green renewal is required to ensure that students have access to the latest tools and resources in STEM fields. The availability and integration of new technologies such as interactive whiteboards, virtual reality headsets and Generative AI, virtual and augmented reality, is essential to ensure a more hands on learning experience.

4.3.2 Ongoing PL&D

Ongoing provision of professional development and training opportunities to ensure staff keep pace with the rapidly changing field of STEM and uphold the necessary interdisciplinary skills is required.

Examples include opportunities for staff to gain short/medium term experience in industry, create opportunities for industry to 'guest' lecture on programmes. While there are professional learning and development opportunities available within ETBs, further support is needed to develop staff's digital skills.

4.3.3 Collaboration with stakeholders

Current FET STEM curriculum needs to be reviewed to ensure it are up to date to meet the needs of current industry, particularly the ITC and Mathematics modules. Opportunities to collaborate with HE and Industry to devise joint programmes meeting skills need are evident, providing learners with clear progression through stepped programme and direct links to employment.

4.3.4 Encouraging interdisciplinary learning

FET centres need to restructure their programmes to emphasise interdisciplinary learning and provide learners with a well-rounded education that spans multiple areas of study. Extensive opportunities are available for STEM related skills to be integrated into all courses, to also include and support the increased use of technology with other subjects and through blended learning experiences.

4.3.5 Fostering industry partnerships

There is a need for the FET sector to work with local businesses and industry leaders to provide students with real-world experience and exposure to STEM careers, bridge the skills gap between education and employment, as well as provide access to technology and the resources required for success in STEM fields.

4.3.6 Developing initiatives to support underrepresented learner groups

Mentorship and support opportunities for underrepresented groups need to be in place to help overcome the barriers associated with achieving success in STEM fields. A STEM focused Marketing and Communications Strategy is required to create greater awareness, as well as recognition/excellence awards in STEM.

6. Conclusion/Executive Summary

Overall, schools are well under way with embedding the objectives and high-level outcomes outlined in the STEM Education Policy Statement 2017-2026. The shared responsibility approach taken within this policy has facilitated increased awareness, participation and learning in STEM education at primary and post-primary level. The upcoming curriculum redevelopments at both primary and post-primary level provide significant potential and opportunity to continue to support the implementation of this policy in schools, with appropriate funding/resources in place to overcome aforementioned challenges to same. Likewise, FET STEM is a progressing, dynamic and wide-ranging field, catering for a diverse range of learners at varying levels and with varying support needs, providing for the development of skills and the opportunities for qualifications relevant to regional and national needs. In order to continue meeting the needs of STEM learners and STEM industries, as set out in the FET Strategy 2020-2024, FET STEM needs to continue with investing in technology, providing ongoing staff PL&D opportunities, collaborating with stakeholders, ensuring interdisciplinary learning, fostering industry partnerships, developing further initiatives to support underrepresented learner groups and addressing the digital divide.

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Submission to the Joint Oireachtas Committee on Further and Higher Education, Research, Innovation & Science on "the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.".

At the outset of this submission I would like to highlight the two distinct aspects of STEM that impact at school level.

1. Firstly there are the curricular subjects at post-primary level and courses at third level that are STEM related such as the Sciences, Engineering, the Technologies and Maths.
2. The second aspect, which is somewhat less visible, are the STEM skills that are developed and used in all subjects.

The United Nations Educational, Scientific and Cultural Organisation, UNESCO, in a paper published in 2019 "Exploring STEM Competencies for the 21st Century" outlines their belief that the core feature of STEM is the use of Science, technical and engineering knowledge to solve daily or societal problems. They continue to express that this makes the learning of science, technology, engineering and mathematics more meaningful and contextual for the student. These are the skills that I referred to above that have become essential to a modern way of working and living,

NAPD continue to advocate strongly that, at the earlier stages of their educational journey, students should be exposed to a wide range of educational experiences. This will give them a broad and balanced experience, to afford them opportunities during their formative years to explore, to discover and to develop. During this time students will discover themselves, they will discover their passions, their interests, their aptitudes and they will mature to the point of being able to make informed and robust decisions regarding their future career or study pathway. The job of the school is to equip the student with the skills necessary for their future success both personally and professionally. Skills such as problem solving, critical thinking, collaboration and teamwork. These are skills that are learned while studying the STEM concepts and are easily transferrable to all other areas of study.

While it is widely accepted that STEM skills are essential in a modern world, I would not like to diminish the importance of the Humanities subjects to the development of well rounded, competent and confident young adults. Humanities and STEM are indeed complementary and the skills learned are transferable to every other area of the students life. While problem solving, critical thinking and collaboration are critical for success, the most important attribute that will support the future development of STEM in Irish education is attitude. Creating the positive attitude among students and empowering them with the "can do" attitude and giving them opportunities to experience success, will embed the STEM skills in our system. Every student has some aptitude in STEM and the importance of unlocking these aptitudes for the students cannot be understated. Building this capacity from an early age, consistently, is the only way to unlock previous prejudices that may exist in relation to STEM.

As the student grows and develops, the educational system must respond appropriately to the emerging needs of the student. Each stage of the students educational journey must complement the last and build on that learning. We must insist on a coherent pathway for students with an integrated curriculum that affords the student the opportunities to experiment, to have new experiences, to fail, to succeed and to grow in confidence and competence.

I will endeavour to make a number of points under each of the headings requested,

1. **STEM in Primary Education**

Primary education is the initial and key driver of STEM skills and attitudes. Students are taught, largely, by the same teacher for every subject. The opportunities afforded for inquiry based learning and phenomenon based learning are immense. The curriculum is largely integrated as the same teacher has responsibility for all subjects. The teacher can identify cross curricular links and can exploit transferrable learning. STEM skills can underpin all learning opportunities, for example, while studying Irish, students can be engaged in problem solving, they can be required to collaborate, communicate, engage in teamwork, they can be creative and innovative. Thereby, they are deploying all of the STEM skills, embedding them into the culture of the learning opportunities while the students are actively involved.

Having identified these positives, there are also some significant shortcomings at primary level. As the student remains with the same teacher for the full year, there is a reliance on the expertise and interest of that teacher to embrace the STEM skills. It is up to the teacher to explore opportunities for Technology Enhanced Learning and many schools do not have access to the necessary specialist technology and facilities. This can sometimes present as a challenge.

2. **STEM in Post-Primary Education**

At post-primary, the Junior Cycle curriculum has changed to focus on the Key Skills of learning and we are about to embark on reform at Senior Cycle to bring the Senior Cycle curriculum into line with the Junior Cycle and the Primary Curriculum. Post-Primary is different from Primary in that subjects are delivered by specialist teachers who have trained in specific subjects. This can be the cause of a disjointed experience for students. It can also lead to the abdication of responsibility for the development of certain skills that are not essential for success in that particular subject. The Junior Cycle, with the reduced reliance on content delivery and on the terminal exam, affords opportunities to all subjects to explore cross curricular links and gives every teacher the responsibility for the development of the key skills and statements of learning.

The development of STEM skills cannot be the sole responsibility of the STEM subject teachers. The demands on the curriculum are significant despite the reduction in the requirement for the number of subjects studied. The reduced number of subjects has also had the added consequence of reducing the students exposure to a wider range of subjects and experiences. The Junior Cycle is still in the early stages of embedding and we must be vigilant to ensure we do not return to an assessment driven model, to retain the model with less reliance on content and keep the increased importance of skill development.

The reliance in Senior Cycle on the terminal exam has the added disadvantage of ensuring the priority is on content and knowledge. In addition, the significance of the process of selection of students for third level, creates a mentality where only essential learning is prioritised and skill development is minimised. As students move into Senior Cycle, they are more aware of their interests and aptitudes, they are ready to choose subjects that reflect this and where they are confident they will experience success. A number of new subjects have been introduced into the Leaving Certificate, including Computer Science and in many schools the expertise among existing staff members is limited in order to deliver the subject to students. Curriculum overload can be an issue for many students, particularly when they are studying subjects they are not interested in and may feel they are not good at. Reducing the curriculum content for students has the added advantage of creating time. Time for reflection on the learning, for exploration, experimentation and for embedding the skills, many of which are also the STEM skills that students will have been developing since primary school.

3. STEM in Tertiary Education

As students move into Further or Higher Education the learning takes on a more vocational focus. They generally commence study in the area that they intend choosing to work. Students tend to specialise and build on the skills they have previously acquired. It is vital that what happens at tertiary level builds on the two previous learning stages at Primary and Post-Primary and that students have developed the skills they need for success in their chosen path of study.

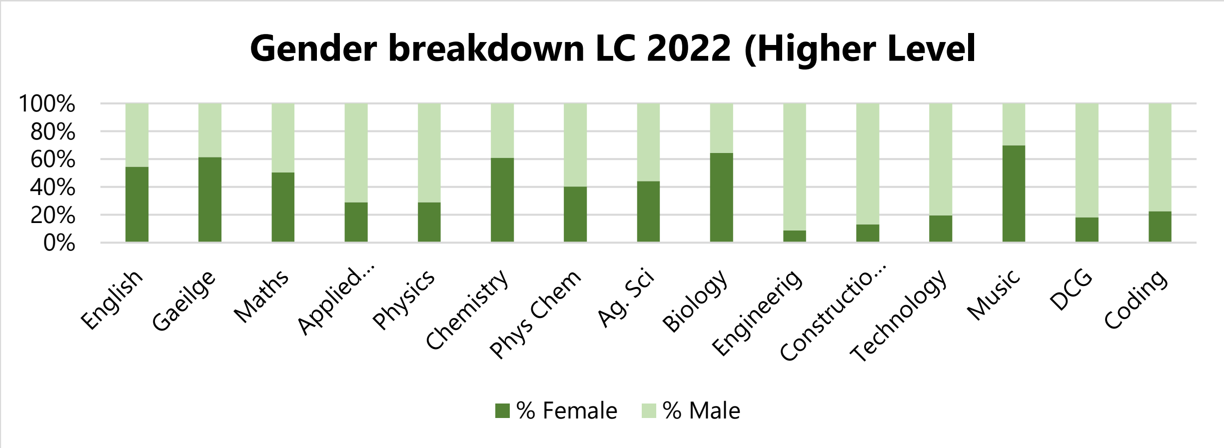
The current method of selection of students for entry to higher education is a significant barrier, at Post-Primary, to affording the students the opportunities to develop problem solving, critical thinking and collaborative learning, all of which are essential for success in tertiary education.

The creation of diverse pathways for students is essential to an integrated system to allow for students to follow their passion. These diverse and varied pathways will create more opportunities for students and create the conditions to break down barriers to studying STEM courses in tertiary education. In addition, many students, who all mature at different rates, can be excluded from access to STEM courses based on a matriculation requirement that is based on their performance in the Leaving certificate. A significant number of mature students enrol in STEM courses that had previously failed to gain access to the course directly following their Leaving Certificate or had dropped out and as such diverse pathways and common entry courses to tertiary education will likely increase participation in STEM courses at tertiary level.

4. Female participation, Diversity and Inclusion in STEM

Goal 2 of the Department of Education Statement of Strategy, 2021-2023, states, "Ensure equality of opportunity in education and that all students are supported to fulfil their potential". This aspiration to provide equality of opportunity equally applies in relation to STEM. Access to STEM subjects in Post-Primary schools is still a work in progress.

Unfortunately, not all schools offer all subjects to all students. Some girls only schools do not offer woodwork or some of the other STEM subjects to students while access to the leaving certificate science subjects can be haphazard. While it is understandable that in smaller schools it may not be economically viable to offer all subjects where there is only small student interest in the subject, there is a responsibility to support the offering of STEM subjects to all students. The graph below highlights where Maths is offered universally to all students, take up at higher is spread evenly between males and females. This graph also highlights the inequality in the subjects offered to females and this is an area that needs to be addressed in the future of STEM.



A number of initiatives are in operation to support the promotion of STEM among females and in disadvantaged areas, programmes such as, Pathways to Technology, PTECH, an initiative run in partnership between the National University of Ireland and the North East Inner City, NEIC, whereby students is some DEIS schools are offered opportunities to participate in STEM activities and gain a STEM qualification. In addition, Fastrack to Information Technology, FIT, operates a "Choose Tech" programme to encourage females to prioritise STEM courses and STEM careers. Recently, funding was granted to Maynooth university for the "STEM passport for inclusion" with the aim that girls in Transition Year in DEIS schools will be given the opportunity to gain a level 6 STEM qualification that can be used towards entry to third level to study in a STEM course. These initiatives are excellent and work towards raising the profile of STEM among traditionally underrepresented groups and removing the barriers for participation in STEM.

The importance of the role of career guidance must also be highlighted. Their role in the broadening of horizons, instilling confidence and encouraging students in the STEM area cannot be underestimated. The career guidance teachers have a significant role in breaking down the barriers to participation and inclusion in STEM while also encouraging females into STEM teaching careers. Their role in building the positive "can do" culture and attitude among students will empower students to increase participation in STEM courses and careers.

Teacher training is another key area to build the capacity of our system to break down the STEM participation barriers. To be able to challenge the student who says "I'm not good at Maths", to work with that student, to guide them to success and to build their confidence will increase the efficacy of the stated Goal 2 in the Statement of Strategy mentioned above.

In relation to Female participation, diversity and Inclusion in STEM, there is a desire to do better, it is clear that a lot is being done, there is more that we can do and we must continue to strive to do better.

5. Digital Strategy in Education to support STEM

The Digital Strategy for schools that was launched in 2022 was very positively received. It is a positive initiative to confirm the continued support for the development of the digital journey for every school and will build on the €223 million that has been allocated since 2015. The commitment in the strategy to resourcing digital infrastructure, teacher professional learning, inclusion and Technology Enhanced Learning are most welcome. The use of technology at post-primary to support learning has increased significantly since 2015. Students continue to embrace the use of technology to support their own learning and have significantly enhanced the development of the practical use of the STEM skills in every aspect of their own learning.

The upskilling of teachers is a significant challenge for schools, along with securing the expertise to manage the infrastructure in the schools. The priority for schools is the use of technology to enhance the learning experience for the student. The quality and continuity of that learning are dependent on the reliability of the infrastructure and hardware. Schools are not appropriately resourced to maintain the network infrastructure and different schools manage this in different ways. To ensure the embedding of STEM skills into every aspect of the school system, provision will need to be made for technical support for schools to manage the physical infrastructure.

Conclusion

STEM in the Irish education system can be seen in the formal sense in the STEM curricular subjects offered and informally in the development of the STEM skills that are universally transferable. The issues in relation to participation rates in STEM subjects among females and marginalised groups in Irish society is not an easy issue to address and will take time to build a new culture that normalises STEM skills to equip students for STEM courses and STEM careers. The key to success begins at a very young age, as we build capacity in the STEM skills areas. Once the STEM skills are embraced, mastered and normalised then participation in STEM courses will increase accordingly.

These suggestions below are made in a solution focused manner to help focus on practical interventions that will have a positive impact on STEM participation into the future,

- Reduce the reliance on the terminal exam as the main mode of assessment used in senior cycle to create time for reflection on learning and skill development
- Embrace meaningful reform of the Senior Cycle to reduce the reliance on content recollection and increase the requirement for skill development to build on the primary curriculum and the Junior Cycle
- Reimagine the pathways to Further and Higher education including the creation of a wider range of pathways for every student. Introduce common entry programmes to allow for specialisation later in the course of study
- Mandate all schools, where possible, to offer all subjects to all students and create opportunities for schools to apply for additional resources to run STEM subjects
- Enhance career guidance opportunities for students and engage professional learning in STEM for career guidance teachers
- Include STEM and digital literacy skills in the initial teacher training
- Create opportunities for cross curricular links between subjects at post-primary to embrace opportunities for new learning opportunities
- Provide technical support to school to manage the digital infrastructure in their school
- Increase the scope and reach of STEM initiatives to engage additional students

Paul Crone	**Paul Byrne**	**Shane Foley**
Director	**Deputy Director**	**President**

National Association of Principals and Deputy Principals (NAPD)
24th February 2023

2023.034(i)

Irish Science Teachers' Association

Eol-Oidí na hÉireann

Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science on the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education with a focus on STEM in Post-Primary Education.

This submission focuses on reform of the current Leaving Certificate Biology, Chemistry and Physics syllabi[1] (specifications). Whilst the focus is on these three science subjects, the submission is relevant to all Leaving Certificate subjects. In this submission we will look at the implementation of the current Junior Cycle Science syllabus, the experience of subjects that had their syllabus changed using the same template for designing the Junior Cycle Science syllabus and some issues with the current drafts of senior science syllabi as they stand.

1. The experience of the introduction of the current Junior Cycle Science syllabus.

1.1 The current Junior Cycle Science syllabus was introduced to schools in 2016 and was first examined in 2019. The syllabus was drafted in a rushed manner and little genuine consultation was carried out within the drafting committee. None of the concerns made by the Irish Science Teachers' Association or by the recommendations made in the Hyland Report (2014) on the template for syllabus design, were taken into account. From the outset, the ISTA made strong representation to the NCCA that the syllabus was unsatisfactory and that it only consisted of a short list of learning outcomes. This problem has been caused by the NCCA using a “learning outcomes only” approach when designing syllabi. The term “specification” as used by the NCCA to describe syllabi is a misnomer. Whilst the term has been borrowed from the UK, the syllabi published by NCCA do not contain the same detail of the syllabi published in the UK. Members of the ISTA who have taught and studied in the UK has made it clear that the term "specification" was introduced in the UK to describe syllabi which had a great depth of treatment specified in the syllabus. Thus, a "specification" is a detailed syllabus. The NCCA has taken the opposite view. This problem has resulted in vague syllabi being published by the NCCA with teachers and students struggling to interpret

[1] * In this paper the term “syllabus” will be used instead of “syllabus” as the term “syllabus” has greater clarity and is the more commonly used term at international level.

what students should know, understand and be able to do on completion of each learning outcome.

1.2 In 2019 the ISTA published the report *Listening to the Voice of Science Teachers*. This report highlighted the major problems encountered by science teachers arising out of their experience of teaching the Junior Cycle science syllabus. Among the problem highlighted were vague learning outcomes, increased stress on students and teachers and the unsuitability of the syllabus template for the Leaving Certificate. Of the 762 teachers who completed the survey, 85% of them stated that they did not wish this “learning outcomes only” template to be used for designing Leaving Certificate subjects. The NCCA has never justified the “learning outcomes only” approach and a freedom of information request to NCCA has shown that there is no justification for using this approach, i.e. the NCCA could not supply any reasoning why a "learning outcomes only" approach was a suitable template for designing syllabi.

1.3 The problems highlighted by science teachers in the *Listening to the Voice of Science Teachers* report were predicted in the Hyland Report (2014). In this report, Professor Áine Hyland, Emeritus Professor of Education, UCC, pointed out that the syllabi being published by NCCA were not in keeping with international best practice as they lacked the details of similar syllabi being taught at international level. At the time of writing, representatives of ISTA who serve on the Biology, Chemistry and Physics subject development groups have been informed that the NCCA is carrying out research into syllabus design. We are glad to hear that research is finally being carried out and we cannot understand why this research was not carried out before work began on syllabus design as a number of people are on full-time secondment in order to carry this work. **It is imperative that the current flawed template of syllabus design is replaced by a template which reflects international best practice and where there is ample evidence that the template has been successfully implemented.**

1.4 Other issues that arose with the implementation of the revised Junior Cycle science syllabus was **the cut to the minimum teaching time from 240 hours to 200 hours**. In reality, this means that in many schools the time allocation for science was cut from five forty minute periods to three periods per week as schools were obliged to spend so much extra time on the topic of wellbeing. We hope that this shortening of teaching hours does not occur at Leaving Certificate level. This has meant that many important topics were removed from the previous well-structured syllabus - especially in physics. Topics such as light, heat, magnetism, static electricity, levers and sound are no longer covered at Junior Cycle level. In the ISTA report *Listening to the Voice of Science Teachers*, 99% of teachers expressed concern at the ‘**dumbing down’** of standards at Junior Cycle science level. Whilst there has always been a jump in standards when moving from Junior Cycle to Senior Cycle science, the difference in standards is now enormous.

1.5 Additional issues that have arisen at Junior Cycle science are:

- The **lack of value placed on practical work**. In the past credit was awarded in the final examination for laboratory practical work (35%). The new 2016 syllabus has very few student experiments specified in the syllabus and no credit is given by the SEC for student laboratory work as part of the final assessment of Junior Cycle science.

- The **lack of clarity on the depth of treatment of topics on the syllabus.** In the past, the Department of Education inspectorate was involved in drafting the syllabus, organising the training of teachers and making out the exam papers. This meant that if any clarification was needed, there was one source that could give a consistent response. Since the establishment of the NCCA and the State Examinations Commission, these functions have been separated. Due to the vague nature of the 2016 syllabus, nobody was willing to provide clarity on the many questions that arose on the implementation of the syllabi. This greatly added to the stress experienced by teachers trying to do their best for students with nobody to clarify what exactly was expected to be carried out in the classroom. This also cause problem for the effective training of science teachers.

- **The lack of any effective in-service training (continuing professional development - CPD) of science teachers in new topics introduced in the Junior Cycle science syllabi.** . The ISTA report *Listening to the Voice of Science Teachers* clearly showed that the vast majority of teachers were dissatisfied with the quality of the training provided. Is spite of new topics such as evolution, formation of the universe, celestial bodies and aspects of genetics, no adequate training was given on these complex new topics. Teachers had to research these topics in their own time and try to estimate the depth of coverage needed to satisfy the needs of the examination. Due to the vague nature of the syllabus, it was clear that the teams tasked with providing the training almost completely avoided the content of the syllabus and concentrated on topics tangential to the syllabus. One has just to look at the website of the organisation tasked with the provision of CPD to see the poor quality of the materials available to teach the course.

- The **lack of timely sample examination papers**. At Junior Cycle level, a sample paper was issued in the third year of the programme, i.e. a few months before the final examination! We were told from the outset that the examination would look vastly different to previous examination papers. Teacher were expected to teach and assess a new course for almost three years without having any clear indication of what the new assessment would look like. This, is addition to the vague syllabus and lack of useful support material kept teachers in the dark until the teaching of the majority of the course was completed. This added greatly to the stress experienced by teachers.

2. The experience of the introduction of Leaving Certificate syllabi using the same template as was used in Junior Cycle

2.1 Leaving Certificate subjects such as Computer Science, Agricultural Science and Politics and Society had their syllabi introduced using the same model as had been used at Junior Cycle Science. Research has shown that teachers have experienced similar problems to those encountered at Junior Cycle level, e.g. lack of clarity on the depth of treatment, lack of effective CPD, lack of clear guidance on the correct implementation of the syllabus, lack of timely sample examination papers and unexpected areas being examined on the final examination papers. A number **of schools have removed Agricultural Science from the curriculum as teachers are unclear as to the precise content of the syllabi**. The numbers of students taking agricultural science has dropped from 8510 in 2020 to 7413 in 2022. This **represents a drop of 13% of students taking agricultural science in 2 years** at a time when the total number of students completing the Leaving Certificate has increased.

2.2 STEM are perceived as 'difficult' subjects in their own right. **We do not want to add to this perception by being forced to teach inadequate syllabi, inadequate CPD training and support as well as lack of alignment between examination papers and syllabi.** Unless this problem is tackled and resolved, we will certainly see a decline in students opting to take STEM subjects at senor cycle.

2.3 The draft syllabi as they stand at the moment. The latest draft of the revised Leaving Certificate Biology, Chemistry and Physics syllabi have not yet been released.

We are very concerned at the continuing lack of depth of treatment, lack of clarity on mandatory student practical work and lack of clarity on the release of sample examination papers. To date, all efforts made by the ISTA to voice our concerns have been met with a blank wall by the NCCA. We hope that we are not again presented with a flawed template of syllabus design at Leaving Certificate level.

3. Recommendations

As part of our research into effective syllabus change, we summarise the recommendations of the Hyland Report commissioned by the ISTA. Professor Áine Hyland, Emeritus Professor of Education UCC, has made a huge contribution to reform in Irish education and is a giant in education at international level.

In summary we make the following recommendations:

3.1 A new syllabus template needs to be developed for all syllabi at Junior Cycle and Leaving Certificate level. This template must contain more detailed information about the depth of treatment of subjects including the linking of learning outcomes to teaching and learning activities and to assessment.

3.2 The full range of documentation must be available before implementation of the syllabi. This full range of syllabus documentation (including depth of treatment within the syllabus, sample examination papers, sample marking schemes, etc.) should be officially published at the same time as the syllabus itself, under the logo of the DES as has been the case in the past. This elaborated documentation should be available well before the syllabus is due to be implemented, to enable teachers to become familiar with the new material and to undergo appropriate CPD (continuing professional development) and up-skilling programmes. This the standard practice experienced by science teachers who teach syllabi which are recognised at international level, e.g. the International Baccalaureate and the syllabi published by the OCR (Oxford, Cambridge and Royal Society of Arts) in the UK for GCSE and A- level subjects.

3.3 Depth of treatment embedded within the syllabi. From 1989 until recently, Leaving Certificate syllabi included the level of detail that teachers expect and need to enable them to prepare their students for the Leaving Certificate public examinations. That level of detail has also been used and will continue to be required by the SEC to enable them to set and mark the Leaving Certificate examination papers. It is essential that that current “learning outcome only” vague template be immediately abandoned and a more appropriate template be implemented.

3.4 Continuation of syllabus subject development groups. We recommend that the present structure of subject development groups for drafting syllabi should continue. These committees should be reconvened to begin the work of redesigning all subject syllabi, using a new agreed template. Such a template has been published in a recent paper (Hyland and Kennedy, 2023) and is available on https://www.ista.ie/wp-content/uploads/2023/02/Template-Syllabus-Design-AH-DK-1.pdf

These subject development groups should continue to be involved in the identification and where relevant, the development of resources to support the new subject syllabi. Members of subject development groups contribute invaluable expertise and experience, on a pro bono basis, to Irish education. They help to bridge the gap between theory and practice, between the ideal and the possible. Teachers, in particular, have an important role to play as we are at the chalk-face on a daily basis and bring knowledge of the on-the-ground constraints to the discussion. Third level and employer representatives help to ensure that the revised syllabi prepare students appropriately for further learning and for work. The partnership model has served Irish education well in the past and will hopefully continue to do so in the future.

3.5 Sharing of syllabus documentation from other countries. Consideration should be given by the Minister to collaborating with other bodies, nationally and internationally, to provide appropriate state-of-the art materials thus avoiding unnecessary and expensive duplication or “re-inventing the wheel”. This may be more relevant to some subjects than to others. For example, as science subjects are less culturally bound than some other subjects, resources developed for science teaching in one country are likely to be relevant and suitable for teachers and students in another country.

3.6 External evaluation. We recommend that an external, independent evaluation of Junior Cycle Framework and the Leaving Certificate subjects that have recently been implemented using the same template as was used at Junior Cycle. This external evaluation should be carried out by personnel from outside Ireland by experts in curriculum design. This will provide **an authentic evaluation** to enable us to plan for the successful implementation of new Leaving Certificate subjects. We are conscious of the fact that one teachers' union has instructed its members not to cooperate with an evaluation of the Junior Cycle Framework due to a perceived conflict of interest.

It is our earnest wish that the above recommendations be implemented as quickly as possible in a collaborative and diligent way that is respectful of the views of teachers and of other stakeholders in the world of education.

Conclusion

We do not wish to see the excellent Leaving Certificate Biology, Chemistry and Physics syllabi currently being taught in our schools being destroyed and replaced with inferior and vague “specifications” that are not of international standard. We have exhausted every avenue by writing to the NCCA and meeting with NCCA but have made no progress.There does not appear to be any quality assurance system in operation to ensure that the curricula being designed by NCCA are in keeping with international best practice. This Oireachtas Committee is our only hope of saving the subjects of Physics, Chemistry and Biology from being severely damaged.

We appreciate the committee has already recommended “*As part of senior cycle reform, a key priority for the Department of Education must be that the revised syllabus for each subject is far more detailed with comprehensive instructions for teachers. The Committee recommends that the NCCA reviews the proposed design of the new syllabi to ensure teachers are properly supported and students taught to the highest professional standards”.*

We would like the committee to continue this recommendation in your report on *Further and Higher Education, Research, Innovation and Science to the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education with a focus on STEM in Post-Primary Education.* All the issues predicted in the Hyland report have come to pass and have damaged many subjects.

The ISTA wishes to express its sincere thanks to the members of the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science for taking the time to study this submission.

2023/035

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Irish Mathematics Teachers' Association

Submission to Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

FEBRUARY 27, 2023

1. Introduction

1.1 The Irish Mathematics Teachers' Association is the national association representing and supporting Mathematics Teachers in post-primary schools in Ireland. Our membership continues to grow steadily each year and we now represent and support over 1,300 teachers of mathematics in the 2022/23 school year. This has grown from a figure of 669 in 2019/20. We communicate with our membership regularly, and offer CPD opportunities, conferences and competitions for post-primary students to promote mathematics in a fun and competitive spirit. We also gather members' views on the pressing issues of the day including, but not limited to, curricular developments at Junior Cycle and Senior Cycle, assessment issues including feedback on State Examination Papers, and emerging developments such as those faced in the light of the Covid-19 pandemic. We have gathered much data from our members (and from students) as to their views on some current issues and the future of mathematics education and are delighted to be afforded an opportunity to submit these here. We have surveyed our membership on two recent occasions with response rates of 434 and 444 respectively. The results of these surveys form the basis of many of our points.

1.2 In responding to queries about STEM education, we note that mathematics is a basic discipline in the STEM area. Difficulties have been encountered in trying to spread it across STEM and integrating it with other STEM subjects. In this submission therefore, while noting exciting possibilities for integration and cooperation with other subject areas, we will focus on mathematics as a free-standing subject. We will focus on the following five key areas: Junior Cycle mathematics, Leaving Certificate mathematics, Teacher education, female participation in STEM, and mathematics at primary level.

2. Junior Cycle Mathematics

2.1 The last three years have been difficult for us all in education, and implementing a new specification during a global pandemic is not without its challenges. However, our surveys indicate strong feelings among our respondents about the revised Junior Cycle (JC) specification for Mathematics.

2.2 When asked to state their level of agreement with the statement "Higher Level JC maths prepares students appropriately for Leaving Certificate (LC) maths", only 25.7% of teachers agreed or strongly agreed. As a country focusing its attention on STEM and all it has to offer, this is a most worrying statistic.

2.3 Our members are of the belief that the current JC specification is too long and cannot be adequately delivered in the context of decreased class contact time in many schools. The introduction of 400 mandated well-being hours at JC is having the adverse effect where teachers are frantically trying to squeeze in so much material, often in a very superficial and superfluous way. Many schools have seen reductions in their class contact time with JC students to facilitate the timetabling of wellbeing subjects, with some saying they see 2nd year students only twice per week. There is no time allowed to fully explore the concepts being taught in the manner that is recommended by the Inspectorate. To fully embrace a new mathematical topic, students need time to practise the skills associated with that topic, then need time to make the necessary links to other topics across the specification as outlined in its unifying strand. Ultimately, for students to fully understand a topic they need additional time to embed the skills associated with the concept while also seeing applications of the skill in any real world scenarios.

2.4 Most notably, however, has been the demotion in the importance of fully understanding the topic of algebra in an entity in its own right. Our members assert that algebraic skills have been diminishing over time since the introduction of the Project Maths examinations in 2012, but the 2022 examination further compounds this. While we acknowledge that the 2022 paper was set in the backdrop of Covid and a disrupted junior cycle, the examination paper has only one question with explicit requirements to do any algebra. It was worth 25 marks out of 220. Algebra is no longer seen as a beautiful topic in its own right; there is no weight given to the beauty in abstract procedures purely for the sake of themselves. Everything now has to have a reason, a real-world situation or a context to be useful. The net effect of this on a shortage of skills at LC level is clear to see. Students struggle majorly with algebra at this level and it has a knock-on effect to their entire experience of the LC syllabus as a result.

2.5 The “one-size fits all” approach to JC mathematics is having a monumentally catastrophic impact on the subject. The HL course is now trying to accommodate those who would have done Ordinary Level (OL) in the JC examinations, as is the new OL accommodating traditional Foundation Level (FL) students. Neither is working in the eyes of our members.

2.6 We call for serious consideration to be given to the reintroduction of a second exam paper at JC HL, with adequate choice on both papers. Concerns have been raised around students’ poor numeracy skills too.

2.7 Removal of Foundation Level Junior Cycle Mathematics: Our members have expressed very emphatically their dissatisfaction that there is no longer a FL course and corresponding examination at JC level (in survey two, 83% agreed/strongly agreed with the reintroduction of the FL Mathematics examination).

2.8 There is a gap out there for students who are above the Level 2 Learning Programme (L2LP) threshold but still find mathematics challenging. In our survey, almost 60% of teachers disagreed/strongly disagreed with the idea that students who are just above the threshold for L2LP can succeed in OL mathematics. Many of these students have significant additional educational needs and find numeracy and literacy very challenging. The literacy levels on the OL paper are beyond many of these students and their wellbeing and mental health is being adversely affected as a result. Many of these students have disengaged from the education system already and have poor attendance rates.

2.9 Classroom Based Assessments: In our first survey, we asked teachers their attitudes to classroom based assessments (CBAs). In survey one, 80% disagreed/strongly disagreed with the idea of CBAs being beneficial to students with only 10% agreeing/strongly agreeing. Our members question the validity of the CBAs and especially question the time aspect if and when we go back to spending 3 weeks in each of 2nd and 3rd year on CBAs. They assert that the CBAs in the current form do not enhance the learning experience or outcomes for students; they are neither formative nor summative and have the potential to allow students embed misconceptions. We would call for a maximum of 1 CBA to be completed going forward (98% of respondents agree/strongly agree with this from survey two); we suggest keeping the CBA on statistics which would be done in 2nd year. This should be in a coordinated timetabled fashion with other subjects, so students would end up doing a maximum of 5 in 2nd year across all of their subjects and the same in 3rd year. This will vary from school to school but expecting students to potentially do 9 CBAs in each of 2nd and 3rd year is unrealistic and does nothing to aid student wellbeing.

3. Leaving Certificate Mathematics

3.1 Members feel strongly that there must be an element of choice on LC examination papers going forward (93.6% agree with this from survey two). The papers are too rigid and this has a negative impact on effective teaching or any exploration of topics in any great detail.

3.2 The course is proving too long to teach in the time available, with many teachers having to offer extra classes to complete the course (from survey two, 85.9% agree that the course is too long given the current time allocation). 66% of respondents (from survey two) report that they have to give additional classes to students outside of regular timetable to get the LC Higher Level (HL) course completed. Either a reduction in the maths syllabus is necessary as a result (along with choice on papers) and/or an increase in the time provided for LC mathematics needs to be provided.

3.3 While it is admirable that the numbers accessing LC HL have grown steadily since 2012, we have to question whether this is in the best interest of all students and the subject in general. Many students are opting to do LC HL for the 25 Bonus points on offer for a grade of H6 or above. From survey two, 80% of our members would like to see some reform in relation to the Bonus points on offer at LC HL. We would call for a thorough exploration of this complicated issue, to commence immediately.

4. Initial Teacher Education/Teacher Recruitment/Retention

4.1 It is of critical concern to our organisation that there is a serious shortage of qualified mathematics teachers in the state at present, despite excellent initiatives such as the introduction of the Professional Diploma in Mathematics for Teaching (PDMT). One of solutions to this issues is possibly financial in nature. We could incentivise qualified mathematics teachers with suitable financial arrangements.

4.2 We must also ensure that we have enough places and relevant incentives in place for people to qualify as mathematics teachers. Entry to some PME courses is dependent chiefly or only on prior academic qualifications and takes no account of the subject(s) being offered by would-be entrants. The model in which *each subject is preassigned a number of places* allows for appropriate priority to be given to applicants offering subjects in which teacher shortage is most acute. At present, we could be turning away many PME hopefuls each year without knowing the subjects they wish to teach. In particular, we need to ringfence places for STEM teachers.

4.3 For many years, Ireland had an oversupply of applicants for places in mathematics teacher education programmes (though not all applicants were suitably qualified). Increased stringency in required qualifications, together with the extension of the programme to two years with the introduction of the PME, have coincided with – and presumably are related to – a sharp fall in numbers of applicants. Consideration should be given to the length of time taken from entering college to qualifying as a teacher, especially in the situation in which student teachers are not paid. The state should foot the bill for prospective STEM teachers or offer them a full reimbursement of their fees after successfully working as a teacher in an Irish school after 5 years (or similar). We need to offer more supports to newly qualified teachers too and pay them a full 22-hour salary but increase their teaching load gradually over a number of years. NQTs should be mentored for a number of hours per week and encouraged to visit other schools and settings during time that they are not scheduled to teach. We need to nurture our NQTs; not scare them off.

4.4 The Teaching Council (TC) needs to give serious consideration to the requirements it specifies for accreditation of teachers. The present ones impose barriers that exclude good candidates. Several emails to the IMTA from qualified scientists, engineers and data scientists who have studied mathematics to the highest level report that they were told that they do not meet the requirements as set out by the TC to be a qualified mathematics teacher. This needs to be addressed urgently.

5. Female Participation in STEM

5.1 More investment and resources should be targeted at encouraging female participation in maths and STEM subjects in general. A huge campaign needs to be launched by the TC and other bodies to entice the brightest female minds into our profession. A similar ad campaign to the LIDL Ladies Football competition would be a wonderful way to start.

5.2 This is an area in which it may be useful to have some all-female options, analogous to the "CodePlus" programme that has entailed groups of girls working together on projects involving programming / aspects of computer science. Research points to encouraging trends with regard to subsequent uptake of STEM subjects.

6. **Primary School Mathematics**

6.1 It would be worthwhile investigating the amount of time spent on mathematics and numeracy per day in primary school classrooms. Is it uniform across the country/across schools even? Is there scope for some joined up thinking between the two? Many of our members believe that the issues we are facing at post-primary level are a direct result of an overloaded primary curriculum.

7. **Executive Summary**

7.1 In this submission, the IMTA focuses on five key areas related to mathematics education: Junior Cycle mathematics, Leaving Certificate mathematics, teacher education, female participation in STEM, and mathematics at primary level. Regarding Junior Cycle mathematics, the IMTA expresses concerns over the revised Junior Cycle specification, which we believe is too long and cannot be adequately delivered due to decreased class contact time in many schools. The IMTA also notes a demotion in the importance of fully understanding the topic of algebra in the new specification and calls for the reintroduction of a second exam paper at Higher Level with adequate choice. Furthermore, the removal of the Foundation Level mathematics course and examination at Junior Cycle level is a matter of concern for the IMTA, and our members believe that it has adversely affected the education of students who find numeracy and literacy challenging.

7.2 Regarding classroom-based assessments, the IMTA suggests that only one assessment (on statistics) should be completed in a coordinated timetabled fashion with other subjects, rather than the current nine assessments across all subjects in each of second and third years.

7.3 In the case of Leaving Certificate mathematics, the IMTA believes that the syllabus is too long to be completed in the allocated time and that some elements of choice should be introduced into exam papers. Additionally, we would call for a review on the impact of bonus points for Higher Level mathematics.

7.4 The IMTA is concerned about the shortage of qualified mathematics teachers in Ireland and recommends incentivising teachers through financial arrangements. We also suggest that we ringfence places for STEM education courses and provide more support to newly qualified teachers.

7.5 We call for more investment in and resources for encouraging female participation in STEM subjects in general and mathematics, in particular. The IMTA recommends launching a large-scale advertisement campaign to attract more women to the profession.

2023/036

Submission by Áine Hyland, Emeritus Professor of Education, University College, Cork to the Joint Oireachtas Committee on Education, Further and Higher Education, Research, Innovation and Science on the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education with a focus on STEM in Post-Primary Education.

I am writing in support of the submission made by the Irish Science Teachers Association to the Joint Oireachtas Committee on Education, Further and Higher Education, Research, Innovation and Science on the Future of STEM in Irish Education.

I would also like to draw the attention of the Joint Oireachtas committee to a relevant and exciting initiative – the **National Children's Science Centre** (a.k.a. The Museum of Possibilities) **-** which has been in gestation for over 20 years and is now finally about to come to fruition.

Until now, Ireland has been the only country of the OECD and the only member of the EU not to have a national children's science centre – even though there are more than 3,000 science centres around the world that are visited by more than 300 million visitors each year. The need for such a science centre was first officially identified by the then *Irish Council for Science, Technology and Innovation* in 2002, and was reiterated in the *Report of the STEM Education in the Irish School System Review Group* in 2016 where it is stated:

> *"In developed countries across the world, large-scale interactive science centres play a key role in attracting young people into careers in science, engineering and technology. ….. there is a significant void in the Irish STEM environment education environment due to the absence of a first-class, hands-on National Science Centre …. The planned National Children's Science Centre at Earlsfort Terrace should be supported by government as an effective means of stimulating interest in, and engagement with, Stem topics".*

The campaign to set up this centre has been ongoing for over twenty years, and the government decided some years ago to support the venture and to provide a venue and a suitable home for the centre. The location decided on is the North Wing of the National Concert Hall building on Earlsfort Terrace. This building has been unoccupied since the Medical Faculty of University College Dublin moved to Belfield in 2007. An agreement was reached in 2016 that the Office of Public Works would conserve and renovate the building and that the Board of the National Children's Science Centre (a voluntary group of people committed to STEM education) would fund the exhibits and set up a structure to manage and run the centre. The Chief Architect of the OPW, Ciarán O'Connor, together with his excellent architectural team in the OPW, came up with a stunning plan to restore and refurbish the North Wing for the new centre, and planning permission has recently been granted by Dublin City Council. The centre will house three floors of immersive, interactive exhibits and a state-of the art Digital Planetarium with further capacity to host travelling exhibitions.

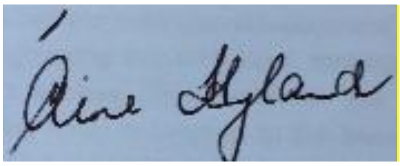
Some objections to the plans have been lodged with An Bord Pleanála in the mistaken belief that part of the new Centre will encroach on the Iveagh Gardens. This is not the case. The Centre will re-establish the original connection between the building and the Iveagh Gardens as it was designed for the International Exhibition of Arts and Manufactures in 1865. The project will actually add to the area of the Gardens with the removal of existing storage buildings, welcoming essential wheelchair access and no part of the new building will extend into this historic Dublin park. We are confident that An Bord Pleanála will uphold the permission granted by Dublin City Council.

There is renewed enthusiasm among the NCSC Board, which is chaired by Michael Collins, S.C., to bring the project to fruition. The board includes eminent scientists Professors Luke O'Neill (Trinity College Dublin) and Brian Ó Gallachóir (University College Cork) as well as Ali Hewson, Jonathan Westrup, Mindy O'Brien, Cathy Moore and Frank Doonan. I am not a member of the board, but I have been involved on a voluntary basis for the past 15 years to give whatever advice I could on the educational aspects of the project. This vital initiative aligns with the government's *STEM Education Policy Statement 2017-2026* which emphasises the need to nurture "*curiosity, inquiry, problem-solving, ethical behaviour, confidence and persistence, along with the excitement of collaborative innovation".* It will also contribute to the implementation of the UN Sustainable Development Goals and will be a resource for teachers in the interpretation of and expansion of the Department of Education's STEM curriculum.

We are now working hard to collaborate with OPW to ensure that no further delays take place, and we are confident that the necessary funding (including philanthropic funding) will be available for fitting out the centre with state-of-the-art equipment and resources.

Further information about the proposed Centre is available on the website www.nationalchildrensscience centre.ie; in the PowerPoint presentation accompanying this submission, or directly from the National Children's Science Centre, North Wing, National Concert Hall Building, Earlsfort Terrace, Dublin 2, D02N527.

We would very much welcome the support and endorsement of the Joint Oireachtas Committee on Education, Further and Higher Education, Research, Innovation and Science for the proposed new National Children's Science Centre on Earlsfort Terrace.



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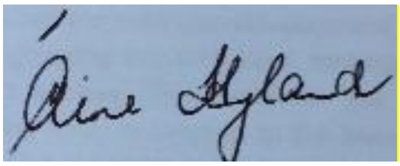

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Because wonder is a precious thing.

A VISION FOR A NEW NATIONAL CHILDREN'S SCIENCE CENTRE

August 2021

MUSEUM OF POSSIBILITIES

The Landscape

Our species is on a threshold. The world that we are familiar with must change. And we must endow generations to come with the capacity to reinvent their own futures. Multiple crises are forcing us to fundamentally rethink everything we have been told. Climate change, environmental pollution, mass extinction of species, unsustainable levels of consumption, and unconscionable levels of inequality both within and between nations – this is the context that we must empower our children for, so they can create a better future.

MUSEUM OF POSSIBILITIES

The Vision

To empower our coming generations with the essential curiosity, critical thinking and empathy to create a more positive future for all.

MUSEUM OF POSSIBILITIES

Realising the Vision

The Museum of Possibilities is the working title for the new National Children's Science Centre.

Its mission is to activate scientific curiosity in children of all ages, particularly 4 to 16 year olds, through transformative engagement.

This will be informed by a progressive view of scientific literacy, stimulating creativity and problem-solving, while nurturing a sense of social responsiblity and empathy.

It celebrates the power of possibilities.

MUSEUM
OF
POSSIBILITIES

"[Ireland] is the only member state of the European Union not to have a major science centre. This is sending the wrong message to the wider world, which is used to viewing our culture as typically defined by archaeological, mythical, musical and literary heritage. Granted, all of these things are a very important part of what we are, and have been, but Ireland also has a fine scientific heritage that is largely unknown and unappreciated by the general public."

Dr William Reville

EMERITUS PROFESSOR, SCHOOL OF BIOCHEMISTRY AND CELL BIOLOGY, UCC

MUSEUM OF POSSIBILITIES

THIS IS A PLATFORM.

A SPACE.

A HUB.

A COMMUNITY.

A NUCLEUS.

A VISION.

ITS PURPOSE IS TO IGNITE CURIOSITY.

Igniting Curiosity

Tomorrow will not wait for us to catch up. It will not grow less complex, become less connected, cast off its digital dependencies. Science and technology will not play a smaller role in our day to day lives.

How are we going to activate the fabulous creative, scientific potential of our children to reveal itself? How can we start them believing in the power of possibilities? How can we prepare them to transform the future?

Fom their earliest years, we want them to become creative thinkers and problem solvers, technologists and biologists. We need artists and mathematicians, digital experimentalists and coding gurus.

We need a box in which to think outside the box. Where science and art, data and imagination collide – and excite. A home for inspiration and innovation, a platform on which to ignite curiosity and imagine the future to which we aspire.

MUSEUM OF POSSIBILITIES

Museum.4

The Museum of Possibilities will be at the vanguard of the so-called fourth generation of science museums as proposed by Erminia Pedretti and Ana Maria Navas Iannini.

"Science museums have been with us for centuries and have been visited by millions worldwide. They are places in which different publics come to explore, play, observe, discover, and perhaps learn some science along the way. Over time, science museums have reinvented themselves, shifting and/or expanding their purposes and functions, and moving through different generations.

Once dominated by a focus on collecting and preserving, and later communicating science through hands-on experiences, science museums are slowly reshaping their identities and social goals to explicitly include and promote active citizenship, social responsibility, engagement with complex science and technology issues."

MUSEUM OF POSSIBILITIES

More Than Temples

Cité des Sciences in Paris exemplifies a fourth-generation science museum. In addition to interactive exhibitions, through a series of innovative public forums, visitors are invited to participate in dialogues around topical issues such as global warming, emerging technologies, privacy - transforming how spaces and practices can stimulate conversation, participation, and engagement in decision-making.

The Science Museum of Minnesota ran *Race: Are we so different?* for visitors to understand what race is and what it is not. Combining media resources, interactive components, imagery and community programming it invited visitors into a conversation about the reality — and unreality — of race in contemporary American life.

Mutare Museum in Zimbabwe tackled socio-geology and economics with *Ngoda: The Wealth Beneath our Feet* focusing on the illegal diamond trade and the accounts of villagers removed from extractions zones, becoming a forum for public dialogue. This bold exhibition led to social change, even reframing the museum and community identities

Rio de Janeiro's Museum of Tomorrow has become known for one of the planet's most powerful arguments for sustainability. Mixing science and art, devotes itself to the need for change if mankind is to avoid climate disaster, environmental degradation and social collapse. It asks "How do we want to live together over the next 50 years?"

MUSEUM OF POSSIBILITIES

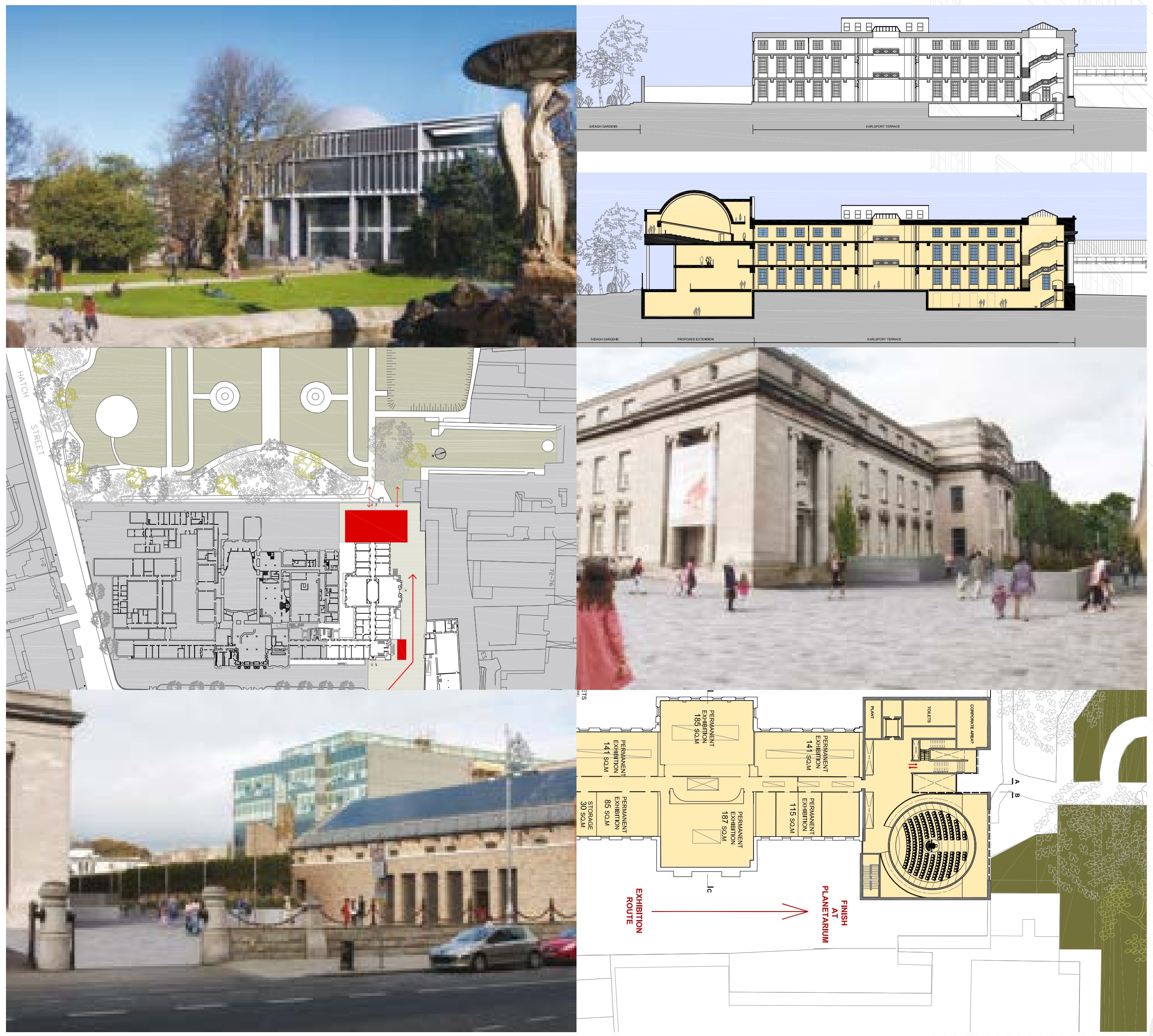
Location

In 2016, led by the State Architect, planning permission was granted to the Office of Public Works to build the National Children's Science Centre at the North Wing of the National Concert Hall on Earlsfort Terrace, opening into the Iveagh Gardens. A synergy of science, music and nature in the capital's cultural quarter.

As each age builds on its past, the site will comprise the renovated Wing with a new extension to the back incorporating a state-of-the-art Planetarium. Rhyming with history, a tunnel will link this main building with the old UCD Engineering Lab, which will also be reimagined to house temporary and travelling exhibitions.

The overall footprint will be ca.9,500sqm, with 2,500sqm of permanent engagement space and 500 square metres of flexible exhibition capacity.

MUSEUM OF POSSIBILITIES



Much more than a bricks and mortar institution, more than a powerful, immersive, interactive celebration of science and technology:

it's an idea whose time has come.

MUSEUM OF POSSIBILITIES

The vision for a new national children's science centre aligns with Irish Government policy commitments in this area.

"In line with our ambition to have the best education and training servicein Europe by 2026, Ireland will be internationally recognised as providing 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."

STEM EDUCATION POLICY STATEMENT 2017-2026

A Shared Positivity

Partnerships with Government, with industry and with universities have been central to progress to date in developing the science museum concept - and its future success depends on expanding and empowering these relationships.

As Ireland aims to be a major player as a knowledge-based economy, it’s a bold statement of intent. This is a lab to cultivate a new progressive, scientific citizenship. To seed wonder and curiosity from the early years.

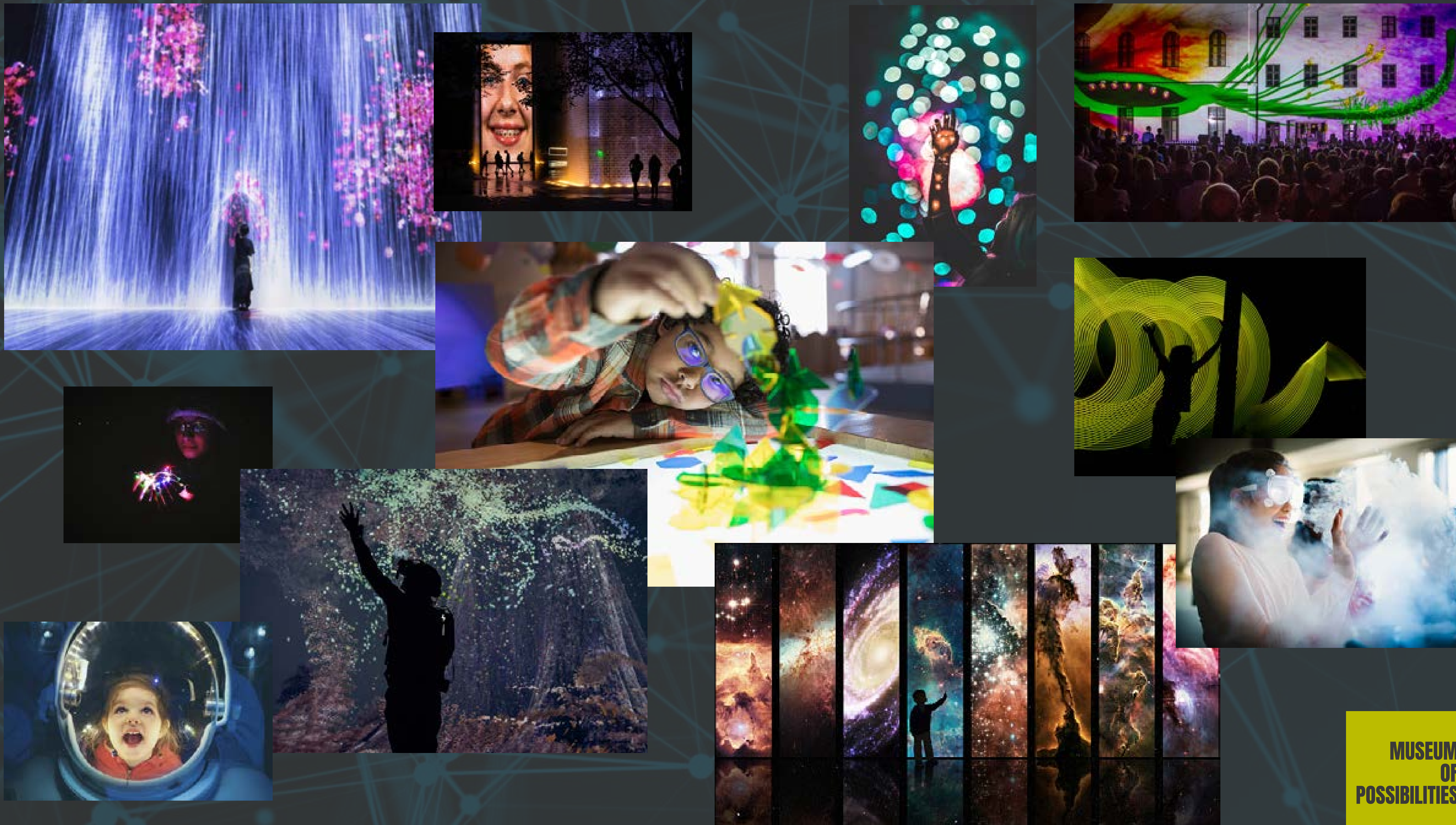
We need to grow the country’s science capital in order to lead the transformations essential to facing tomorrow’s challenges. To shape our world, we must understand it.

MUSEUM OF POSSIBILITIES

I rejoice in the creation of
the National Children's Science Centre.
Growing up in a small Irish country town,
I heard and saw nothing of science
until I was 13 years old.

Long may it flourish

Prof. William C. Campbell
2015 Nobel Prize Winner



MUSEUM
OF
POSSIBILITIES

February 24th 2023 2023/037

1. **Introduction**
I am an expert in the use of digital technology in education and have co-authored reports for the EU on the use of technology in education. I have also evaluated European project proposals focussing in particular on the areas of education and digital technology in compulsory education. I welcome the opportunity to make a written submission to the Joint Oireachtas Committee on Education, Further and Higher Education, Research, Innovation and Science as part of the Committee's examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education. I have noted the request for comment on the Future of STEM in general. The main focus of my submission will be the Digital Strategy in Education to Support STEM. I would like to take this opportunity to highlight the efficiency, quality, access and equity in the current digital strategy and associated funding.

2. **Executive Summary**
Schools, particularly post-primary schools, have changed remarkably since March 2020 and the Inspectorate's "Looking at Our School 2022" acknowledges this in its quality framework[1]. In February 2020 a review of tablet devices and how they were used in one school was formally published (Dunne et al, 2020)[2]. There was no opportunity to discuss the findings and recommendations of this review as the country was in the grip of the pandemic. We are now in the grip of a cost of living crisis. More schools require students to purchase a mandated device to participate in everyday classroom activities and complete parts of the state examinations. We need wider societal dialogue about how technology is embedded in our schools.

3. The six key skills of junior cycle are Managing Myself, Staying Well, Communicating, Being Creative, Working with Others, and Managing Information and Thinking. The use of ICT has been embedded into all six key skills for Junior Cycle (NCCA, 2012, 2015)[3]. A growing number of schools require students in first year to have a device in order to carry out classroom tasks in many of their subjects. Tasks requiring a device are also detailed in some of the textbooks used in school. Yet, the Department has not resourced this level of support for students and teachers in school. This is analogous to requiring students to perform experiments in Science without providing any resourcing to schools for lab space and equipment. In May 2022 the Minister for Education announced the publication of the Digital Strategy for Schools to 2027. The strategy was developed after a consultation process that involved many stakeholders including children at primary school, students at post-primary level, their parents or guardians, teachers and school leaders.

4. **My Recommendations**
    1. The DES should consider a centralised approach to both the procurement and provision of digital devices and the necessary ICT systems in order to support well-informed digital school policies and investment.
    2. The DES should provide a recommendation regarding a common minimum standard for both student and teacher devices.
    3. A circular was published in 2017 providing recommendations on uniform purchases. A similar approach is necessary for the purchase of technology and associated services until a centralised approach and formal tendering process can be devised.

[1] Department of Education and Science. (2003). Looking at our school 2022: A Quality Framework for Post-Primary Schools. https://www.gov.ie/en/publication/b1bb3-looking-at-our-school-2022/
[2] Dunne, C., O'Dalaigh, C., & Marcus-Quinn, A. (2020). Report of the Independent Review Group (IRG) on the use of tablet devices in Ratoath College (RC) https://ulir.ul.ie/bitstream/handle/10344/9686/Marcus_2020__Quinn_Report.pdf?sequence=2
[3] NCCA. Key Skills of Junior Skills (2012). https://www.curriculumonline.ie/getmedia/def48e3f-68f9-42e4-95de-f30086321fd0/JSEC_Key_Skills_of-JC_English).pdf

5. **Digital Strategy and Digital Devices**
The new digital strategy for education has embedded ICT use into the skills for Junior Cycle. We can expect the reformed Senior Cycle to follow suit. This is progressive, in many ways, as technology becomes more and more embedded in many aspects of our daily lives. The digital strategy for post-primary is ambitious and provides a comprehensive roadmap which endeavours to ensure that our school system is preparing our school communities for the modern world. However, when the Department of Education embedded the use of technology into the Junior Cycle, the provision of adequate access to technology was not sufficiently considered in the budget available to schools.
International research recognises the need for appropriate investment in technology in education. In the final report of the EU expert report on Quality Education for the EU Commission the authors have recommended that significant policy attention and investments should be made to improve the digital infrastructure in schools. This involves hardware, technical support, and software (Fack et al, 2022)[4]. The Department of Education has increased the level of investment in the digital strategy for schools in recent years. However, given the level of funding available and the autonomy of schools there remains a great deal of inequality in terms of how technologies are used to provide a quality and equitable education for all.

6. There have been many studies focussing on the student experience and engagement during the pandemic (Mac Domhnaill, 2021)[5]. These experiences have certainly informed the consultation process on the most recent digital strategy. When asked about the digital infrastructure that is most important to enable the use of digital technologies in teaching and learning and assessment teachers ranked the need for a device for teachers as the most important aspect of the digital infrastructure. Teachers placed the need for devices for learners in second position. Since Covid we have seen a welcome increase in grant funding for digital technology infrastructure to both primary and post-primary schools. This funding is a foundation step to covering the visible and invisible cost of such an ambitious strategy. As part of the consultation process students were asked if they have access to a digital device to use in school during class when needed. Some 121 (85.8%) responded with a Yes and 20 (14.2%) with a No. Students also reported using a mix of devices (laptops, tablets and smartphones) but there is an inequity in the classroom as only 72 students (52.9%) stated that the device that they were using to carry out necessary classwork was provided by school and 64 (47.1%) reported that their device was provided by themselves. Currently, in Ireland this expectation of device ownership is dependent on the policy of each individual school (Marcus-Quinn et al, 2019)[6]. Some schools will provide staff with a complementary device as part of the school's contract with an external technology provider. However, the provision of devices to all teachers in Ireland is certainly not mandated by the DES and is dependent on the internal policy of any given school. There are now three dominant scenarios in schools with varying degrees of inefficiency, poor value and a compromised teaching and learning experience for both teachers and students. The less well-off are often the most impacted.

7. **Scenario A:** The school is a 1:1 device school. Every student must purchase a specific branded tablet for classroom work. Personal devices including Apple's iPad and Microsoft's Surface are often compulsory purchases. Some 23 percent of parents responding to the 2022 Barnardos survey stated that they had to pay over €300 for digital technology for their child. For many parents the cost is closer to €1,000 when other costs are factored in. In this scenario all children have a device with them at all times and can engage in spontaneous teaching and learning activities that require a device. All students can complete

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[4] Fack, G., T. Agasisti , X. Bonal, K. De Witte, D. Dohmen , S. Haase , J. Hylen, S. McCoy, M. Neycheva , M. Carmen Pantea, F. Pastore, A. Pausits, K. Poder, J. Puukka and J. Velissaratou (2022). Investing in our future: Quality investment in education and training, Luxembourg: Publications Office of the European Union, https://www.esri.ie/publications/investing-in-our-future-quality-investment-in-education-and-training
[5] Mac Domhnaill, C., Mohan, G., & McCoy, S. (2021). Home broadband and student engagement during COVID-19 emergency remote teaching. *Distance Education*, *42*(4), 465-493.
[6] Marcus-Quinn, A., Hourigan, T., & McCoy, S. (2019). The digital learning movement: How should Irish schools respond?. *The Economic and Social Review*, *50*(4), 767-783.

their tasks independently. Schools do not have to provide a device for every student. This scenario puts a financial burden on parents that varies widely depending on the school. Not all 1:1 device schools are using the same quality of digital content. In some schools teachers cannot use textbooks/eBooks. Teachers may have to develop their own digital resources. This expectation of such content development is leading to several problems including copyright concerns and an undue burden on teachers to become instructional designers.

8. **Scenario B:** The school has a Bring Your Own Device Policy (BYOD). The range of devices being used varies hugely. The school has no control over what social media etc. is accessed during the school day. It is much more difficult to implement any kind of digital policy in this scenario. The risk of child safeguarding issues is much higher. This scenario essentially forces some families to buy their 12 year olds a Smartphone. Research (including the ESRI) provides evidence that children under 13 with a Smartphone are negatively impacted. There is also a financial cost to parents.

9. **Scenario C:** The school has appropriately equipped ICT labs and/or an adequate trolley system in place for the use of technology in class. Everything is monitored and safer. No personal devices are used. This type of scenario requires significant funding.

In scenario A and B students often end up having to use their own data plan. Again, adding to the costs associated with the use of technology.

10. COST and Autonomy of Schools

The most recent October Returns from the Post-primary Online Database (P-POD) are for the Academic Year 22/23. There were 406, 457 registered students at post-primary. If each student was to be provided with a device the Department should be in a position to negotiate a rate for this type of bulk purchase. The 2008 Digital Educational Revolution in Australia (DER) is worth looking at for cost at a large scale. Currently, there is no tendering process for the purchase of devices at second level. The Minister for Education frequently reminds the public that schools in Ireland are autonomous and "decisions regarding the deployment and use of digital technologies are a matter for the management of schools as they are best placed to determine this according to their own situation and requirements." However, given that technology is now embedded in the Junior Cycle and considering the expense associated with this technology, is it not time to revise this policy in the context of technology?

11. At third level the use of ICT is supported by large IT departments and HEAnet, the National Education and Research Network, provides brokerage services to help third level clients to streamline their ICT procurement processes. There is also an online HEAnet Store which provides a wide range of educational discounts on ICT hardware, software and other services for students, staff and researchers across the country. There is a need for a similar collective bargaining at second level. Second level schools have ICT/digital learning coordinators. These members of staff identify the teaching and learning needs of their colleagues, liaise with the device provider, communicate with the school community and solve some of the day to day IT issues. Usually, schools also have a part-time technician. But these roles are not sufficient to meet the growing needs of a large school community. There is a strong argument to be made for schools to have full-time technicians on their staff to deal with technical issues and to resolve problems quickly.

12. The National Parents Council and Barnardos have called on the Government to introduce free schoolbooks, make affordable uniforms the norm and to end voluntary contributions. The expectations around the provision of technology also needs to be discussed as part of this process. It should not be compulsory for students to have overly-expensive digital equipment, particularly when such purchases put parents under extreme financial pressure and in some cases puts them into debt. There was a circular

giving recommendations on uniform purchases in 2017.[7] A similar position on technology should be put in place as a matter of urgency.

13. It is also worth looking at international best practice such as Estonia's highly regarded Tiger Leap Foundation or the later Digital Educational Revolution in Australia (DER) and learning from their experiences. In 1997 Estonia set out to provide all schools with computers and internet as part of broader strategy to build an information society (Aru-Chabilan, 2020; Põldoja, 2020)[8][9]. In 2008, the Australian federal government initiated a national policy to provide all secondary students and teachers with new and upgraded information and communication technologies. This initiative was to ensure that students and teachers had the same access to the digital technologies necessary to support learning and prepare students for full participation in future society and ran from 2009-2014. Some aspects of both the Estonian Tiger Leap programme and the DER programme worked extremely well and some were less successful (Velmet, 2020; Niederhauser et al, 2018)[10][11].

14. **Well Being**
Where students attend a school with a 'bring your own device' (BYOD) policy the range of devices being used varies hugely. The school has little control over what social media etc is accessed during the school day. It is more difficult to implement a clear digital policy in this scenario (Garba et al, 2015; Dunne et al, 2020; Feerick et al, 2022)[12][13]. This scenario also forces some families to buy their 12 year olds a Smartphone despite evidence that children under 13 with a Smartphone can be negatively impacted (Dempsey et al, 2020)[14]. Currently, many teachers are also still using personal devices such as phones, laptops, visualisers and wifi speakers, although this is gradually being phased out due to recent GDPR legislation (Murphy et al, 2021)[15]. Some schools are recognising the harm that can be associated with access to a smartphone during the school day and are putting policies and procedures in place to enable students to safely store their smartphone during the school day[16].

15. How technology has been mandated in teaching and learning environments and embedded as part of the new Junior Cycle key skills in all subjects has created a much more complex relationship between industry and the education sector. Technology in schools is often described as both necessary and also a solution in search of a problem. We need wider societal dialogue about how technology is embedded in

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[7] DES (2017) Measures to be adopted by schools to reduce the cost of school uniforms and other costs https://circulars.gov.ie/pdf/circular/education/2017/32.pdf

[8] Aru-Chabilan, H. (2020). Tiger Leap for digital turn in the Estonian education. *Educational media international*, *57*(1), 61-72.

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[16] https://www.irishtimes.com/news/education/a-school-smart-phone-policy-they-re-talking-to-each-other-more-1.4844016

our schools. Internationally, there is a growing body of research on the use of Artificial Intelligence and the emergence of facial recognition software in schools[17]. There has been some pushback against the use of such software in the workplace and in wider society yet it is now being embedded in some Australian schools. In some cases it is welcomed as an administrative aid to support recording of non-attendance by some students. The issues around the collection of biometric data and concerns around the storage and use of such data should be a concern to all of us.

16. In the consultation with teachers it is clear that the majority of teachers at both primary and post-primary engage with the digital supports and resources that are available to them. The Digital Strategy recognises that effective digital learning planning is essential in order to ensure that schools can successfully embed the use of digital technologies across the curriculum. The reports on the consultation process that helped to inform the Digital Strategy are available to download from the Department website. The reports on the findings from the post-primary students questionnaire and the post-primary teachers questionnaire issued as an element of the overall consultation process for the development of the new Digital Strategy are worth reading as it is clear that the voices of stakeholders mattered[18]. When asked if there was any particular area or subject a new Digital Strategy for Schools should include, most students had no opinion or didn't know but some students did respond thoughtfully. Students have asked that the digital strategy include coding, fast broadband, access to devices and online safety. The data collected from teachers echoed these issues. When teachers were asked about barriers or obstacles they reported insufficient broadband, a lack of resources for both mainstream and special educational needs (SEN), a lack of time, access to devices and GDPR concerns. Another question asked students if they, or their fellow students, have been involved in the development of any policies on the use of digital technologies in their school? Of the total 138 respondents 28% of students responded with a 'Yes' to this question. The school digital policy is an important document and it is very positive to see that the student voice has been consulted in the development of school digital policy. This number will grow as we look forward to seeing the Education (Student and Parent Charter) Bill being passed in the Dáil.

17. Final Remarks

Stakeholders recognise that the use of technology in education can be progressive and extremely beneficial for students. The new digital strategy is our best roadmap to date in terms of building digital skills and competencies. Devices are an attractive option for many schools as having a tablet or a laptop can negate the problematic issues that can arise with smartphones. However, changing the current systems (tender process) to improve the value of these purchases for both teachers and students at post-primary is critical if equity of the digital experience is to be achieved.

I am available to discuss any of the above submission directly with the Committee on Education & Skills and/or with members of the Working Group on Oireachtas Procedures.

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2023/038

Joint Committee on Education, Further and Higher Education, Research, Innovation and Science.
Leinster House
Dublin 2
D02 XR20

27th February 2023

Reference: Enterprise Ireland Written Submission on the Examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

Chair, Committee Members,

Thank you for your recent correspondence dated 25 January 2023 inviting Enterprise Ireland to make a brief written submission, as part of the Committee's examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

Enterprise Ireland (EI) is the government organisation responsible for the development and growth of Irish enterprises in world markets. We work in partnership with Irish enterprises to help them start, grow, innovate, and win export sales in global markets. In this way, we support sustainable economic growth, regional development, and secure employment.

In recent client surveys undertaken by Enterprise Ireland, a large number of client companies highlighted that access to skills was a major challenge to their company development and critical obstacle to company growth. The availability of human capital and skilled workforce and the commitment of the education and research institutions to address these needs is critical to delivering Enterprise Ireland's strategic objectives.

Strengthening the STEM skills base is a crucial part of addressing these skills needs. Strengthening the education and training pathways for people to train, learn and upskill in a variety of high-level technical skills is critical to future proof our economy and support the digital transformation of enterprise.

Enterprise Ireland welcomes the opportunity to provide comment on this highly relevant and important area. If you have any further questions in relation to this submission, feel free to contact me directly.

Yours sincerely,

Leo Clancy

Chief Executive Officer,

Enterprise Ireland

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Enterprise Ireland Submission to Joint Committee on Education, Further and Higher Education, Research, Innovation and Science regarding the Committee's examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

In 2022, Enterprise Ireland launched its new three-year strategy, Leading In A Changing World. The strategy sets an ambitious target of creating 45,000 jobs over the next three years and increasing exports by Enterprise Ireland client companies to €30bn. To deliver on this, the strategy sets out five key strategic ambitions for Irish enterprise and for Enterprise Ireland over the period 2022-2024 and beyond:

- Export-focused Irish enterprises delivering growth across all regions
- Ireland as a world-leading location to start and scale a business
- Irish enterprises achieving competitive advantage through customer-led innovation and digitalisation
- Irish enterprises leading globally on sustainability and achieving climate action targets
- Enterprise Ireland providing world-leading service to the companies it supports.

To deliver on these strategic ambitions it is vital that Ireland's labour force is fully equipped with the skills needed to enhance the economic and social development of the country.

As such, Enterprise Ireland welcomes the opportunity to provide comment on STEM education policy in Ireland. Our response is focused around five key points:

1. **Incorporating the Needs of Enterprise into STEM Education Policy**

Direct engagement with Irish enterprises is critical for an agile and responsive STEM Education Policy, supported by clear pathways of enterprise engagement. It is critical that decisions in relation to future STEM Education policy are informed by evidence-base skills data. It is key that funding is channelled to priority interventions to address identified current and future skills needs. Clear skills identification that addresses regional and national skills gaps will facilitate the development of partnerships and skills interventions between industry, key stakeholders, and the Education System.

The design of STEM Education across the system should allow for flexibility to address changes in the marketplace, responsiveness to future skills needs, demographic challenges and student demand. This agility in the system would allow for opportunities for more partnerships across enterprises and stakeholders regionally, nationally, and internationally.

2. **STEM in Primary and Post Primary Education**

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To ensure a STEM skills base of the highest quality that meets the needs of the Irish enterprise base, it is vitally important to build the capability of the student throughout their entire engagement in education – meaning all effective interventions for enhancing the quality and engagement with STEM education in early years, primary and post primary education must be considered. This includes ensuring schools in disadvantaged areas or who lack sufficient infrastructure are supported and connected with other education providers and enterprise engagement, which can support them in their STEM education provision.

Key interventions aimed at enhancing the level of in-demand technical and transversal skills such as problem-solving, design thinking and team working will help future proof the supply of STEM skills in the economy. In addition, interventions that promote awareness of the importance of and the career opportunities within STEM for all student and parents will help increase engagement with STEM education.

Building student numbers taking subjects such as Technology and Computer Science at Leaving Certificate stage in addition to longer-established STEM subjects should be a key priority.

Career guidance towards STEM careers should be a focus, particularly at earlier stages of secondary education.

3. STEM in Tertiary Education

Increasing the number of students choosing STEM pathways in Further and Higher Education, and the quality of that education across all levels of the National Framework of Qualifications (NFQ) is key to any policy statement on STEM education. It is equally important to ensure people sustain their involvement in STEM education throughout their careers by promoting life-long learning, progression pathways and continuous professional development.

In terms of life-long learning, it is essential to sustain and develop a skilled workforce that can adapt and respond to changing skills needs. To achieve this there must be clear and integrated pathways between Further and Higher Education. This focus is very important to support inclusion and diversity, building a pathway of progression that is accessible and supports individuals to build their career and provide development opportunities.

STEM focused Micro-credentials are an opportune way to promote flexible life-time learning. Micro-credentials are very attractive for SMEs as they are flexible, stackable, bite size skills development and individuals can create their own roadmap, mixing skill areas. They are very effective in upskilling and reskilling staff, and support attraction and retention of talent. Micro-credentials need to be encouraged and supported across STEM Higher and Further Education,

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they can also be leveraged for targeted enterprise partnerships and cross-educational programme delivery.

4. **Ensuring all Education Providers have the resources and infrastructure to provide the high-quality STEM Education**

To deliver on Ireland's STEM Education Policy, it is imperative that all education providers are equipped with adequate infrastructure (including high-speed broadband and appropriate digital technologies/learning tools) that facilitates the delivery of high-quality STEM Education. As well as providing the tools needed, STEM teachers/instructors should be given every opportunity to develop and upskill to ensure all students are exposed to the highest quality learning possible. To facilitate this, STEM education staff at all levels must be provided with continual professional development opportunities, particularly as skills, technology and education practices evolve. As such, it is vital that the Digital Strategy for Schools to 2027 is implemented and progress/targets are constantly reviewed to ensure relevance.

5. **Further Promoting and Accelerating Female Participation, Diversity and Inclusion in STEM**

Creating further gender diversity in the STEM student body and tackling other inequalities must remain a key tenet of Ireland's STEM education policy and efforts in this space must be accelerated further. It is evident that diverse and inclusive businesses are more innovative, creative, and dynamic. Supporting the diversity and inclusion efforts of the Irish enterprise base is a key priority for Enterprise Ireland. Continued focus on access to and affordability of education for less privileged groups by virtue of socio-economic background, ability, ethnicity, or other factors must be a priority. All in all, efforts in this space will raise awareness of the opportunities associated with a career in STEM and increase its attractiveness among groups traditionally less engaged in these subjects.

All interventions must be targeted at addressing specific issues affecting gender balance in STEM and female attrition rates at all levels of the Irish education system. Fundamental to this is the provision of the highest quality guidance counselling and mentoring throughout the educational lifetime of a learner to ensure all learners can make well informed decisions about their future careers. It is also important that female and diverse role models in STEM are constantly promoted – demonstrating the very real career possibilities that exist in STEM.

Conclusion

An education system that supports learners through their lifelong career journey is critical for economic growth, STEM skills are a central to this growth. There must be a priority focus on addressing identified skills needs, flexibility in the system to address technological changes and clear pathways of progression for learners and engagement for Enterprise. For policy to be effectively implemented there must be funding for Enterprise Engagement professionals to be placed in each education institution. Government policy and actions that relate to STEM Education such as Digital Strategy for Schools 2027, the EGFSN AI Skills Strategy, and the new National Strategy for Literacy, Numeracy and Digital Literacy, must be aligned to avoid duplication of actions and support effective implementation.

2023/039(i)

Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

Written submission on the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

Introduction

Scientific and technological advances will dramatically alter our existence in the future. As we contemplate those advances, society has a choice - to be led by those developments, or to direct them towards the creation of a society that is safe and equitable. To achieve the latter, we need to create space so that all voices can contribute to how STEM-related advances will influence our world in the future.

An education system that places an emphasis on STEM for all learners will futureproof Ireland in this changing world, enabling our society to respond thoughtfully to the climate and ecological crises and thrive in the face of increasing digitalisation and automation. STEM sills are highly transferable and valued by employers, offering opportunities for trained individuals to do well-paid, valuable work. Three-quarters of the fastest-growing careers in the world require a background in maths or science.

It is essential that STEM education has the capacity to support diversity and equality at all levels. Diversity to look at the same issue through different lenses, to identify the questions that really matter, and conceive of sustainable solutions with broad societal benefits. Equality and inclusion give the full range of talent in our society the opportunity to fully participate, and to shape our collective future.

STEM education should be considered in the context of the full continuum of learning – from early years to lifelong learning. We should also go beyond the traditional boundaries and consider learning supports for parents/guardians and communities.

Launched in July 2021, Creating our Future, engaged the public in a conversation on research. An initiative of the Government of Ireland, the goal was to have an inclusive conversation with the public about the challenges and opportunities that people see in their lives and the role that research can play in addressing them. The voice of the public is reflected in the findings and there is a clear call for education reform within the findings.

One of Ireland's most competitive differentiators on the world stage is our talent and creativity. Education, research and innovation are interdependent processes in our ecosystem: the researchers who are working at the frontiers of research and fuelling innovation, are inspiring, teaching and training the next generation of creative citizens, knowledge workers, and economic and social innovators. A stable and secure career track for the academic community is essential - from early career stage through to leadership roles and in all disciplines.

Under its existing remit, SFI's Education and Public Engagement (EPE) approach aims to grow opportunities for dialogue between science and the public it serves, and to broaden participation both geographically and amongst less represented voices in science. We aim to empower participation, grow talent, and best practice in STEM education and public engagement. An action under *Impact 2030*, the national strategy for research and innovation is a new Research Bill that will create a new competitive R&I funding agency through the amalgamation of SFI and the Irish Research Council. This exciting development will create further opportunities for cross disciplinary research. The challenges we face are multi-faceted and can only be addressed through multidisciplinary approaches. The new agency will also create a diversity of career paths and options for our talented research community.

We recommend the following areas for consideration:

a) Ensuring equal access to STEM subjects for all primary and post-primary learners

b) Developing and fostering inclusive, curiosity driven learning environments – formal and informal
c) Incentivising and facilitating teachers to undertake STEM CPD programmes
d) Further consultation with the scientific community as part of curriculum development
e) Urgent publication of the review of state supports for PhD researchers and further actions to be considered to provide more stability for research careers
f) Invest in doctoral education as a key driver of economic competitiveness and social innovation
g) Invest in and support all higher education institutes with a focus on enabling research talent as a strategic national asset
h) Ensuring that creativity is captured as a key skill in relation to topics in schools such as entrepreneurship and enterprise
i) The voice of the public, as reflected through Creating our Future, is reviewed in the context of curriculum development

1. STEM in Primary and Post-Primary Education

1.1 SFI operates a range of programmes and activities which create opportunities for the public to engage with STEM, to raise awareness of STEM and to encourage growth in participation across society. We place a particular emphasis on those in society that are less represented.

1.2 The SFI Discover Programme, run in partnership with the Department of Education, supports projects that create opportunities for broader participation and engagement of the public with STEM. It also provides opportunities for linkages between STEM and the Arts. The programme enables early support for projects which if proven successful could go on to be scaled up with new partnerships.

1.3 SFI's Curious Minds and ESERO Ireland programmes support teachers and schools (primary and post primary), helping to develop the innate curiosity of children through a hands-on, inquiry-based approach to STEM. We look forward to the Department of Education rollout of a CPD framework to 2026, to inform teacher professional development at primary and post-primary level.

1.4 At the core of our actions is the focus on building STEM learning throughout a life, what we term STEM capital, or all of the access to scientific and technological aspects throughout a person's life. We recognise that young people must be able to apply their creativity and problem-solving skills in real-life situations. Participation in informal STEM education projects such as CanSat and the BT Young Scientist Technology and Engineering offer these opportunities and we would welcome recognition for participating in projects like those as part of any future leaving certificate assessment process.

1.5 The work of SFI in the area of STEM education is informed by and aligned with the Department of Education STEM Education Implementation Plan 2022-2026. The agency is a member of the Implementation Advisory Group and accordingly, is an active participant in discussions and actions across all areas of the plan. SFI chaired the Gender Balance in STEM Advisory Group which has informed the plan.

1.6 SFI is conducting a review of STEM careers awareness provisions to inform the development of new measures for working with learners, parents/guardians, teachers, guidance counsellors and school leaders to raise awareness of the diversity of STEM professionals, pathways and careers and challenge stereotypes in STEM. We are also exploring the opportunities to enhance linkages between Early Learning Centres/Schools and the SFI Discover Centres Network nationwide in order to provide access to integrated STEM programmes.

1.7 The network of SFI Research Centres are a critical component of SFI's Education and Public Engagement initiatives. Centres have dedicated Education and Public engagement workstreams which support our objectives to engage the public in STEM and to grow the number of students choosing a STEM career. Not only are the Centres engaging with teachers and students on the subject matter of their research, they are also introducing novel *ways* of classroom engagement through the cutting edge research that is being developed with the Centres. The Centres that focus on digital technologies are seeking ways to leverage their computer science and software expertise to provide support to the education system and curriculum development.

Suggestions for future action

- Incentivise and facilitate teachers to do CPD courses through formal recognition of programmes such as those run by SFI.
- Further efforts by stakeholders to introduce a mechanism to ensure that creativity is captured as a key skill in relation to topics in schools such as entrepreneurship and enterprise.
- The report on Gender Balance in STEM reflects that young people begin to form ideas about future roles from a very early stage. Enhancing close cooperation between Government Departments focusing on STEM education at the early stages of life and any efforts on the national skills profile would be advantageous.
- Significant expertise and insight reside within our scientific community across many areas that could inform the direction of Irish education. We have a very willing and passionate academic community which could be invited to participate in curriculum development. The introduction of the D/FHERIS Evidence for Policy Unit and associated Civil Service Management Board approval of a proposal to establish Civil Service Research Network (CSRN) has the potential to bring significant benefits in this regard.

2. STEM in Tertiary Education

2.1 STEM in tertiary education and the performance of our research system are intrinsically linked. We believe that an appropriately supported, higher education system, sufficiently well-funded to ensure that the education it offers and the research it conducts is as good as anywhere else in the world, will deliver significant societal and economic benefits to Ireland. Foreign direct investment and indigenous industry in Ireland rely on our higher education institutions to produce a pipeline talent to meet the demands of their business.

2.2 SFI, through a balanced portfolio of research funding programmes which caters for all career levels – PhD to leadership positions - makes concerted efforts to attract and retain excellent researchers within our public education institutions so that Ireland's students are being educated by those that are at the forefront of discovery. The establishment of the new research agency will bring further opportunity to create diversity in the research journey pipeline across disciplines as well as career stage.

2.3 PhD candidates and postdoctoral researchers are the lifeblood of our research and STEM higher education system. Without adequate support for those individuals so that they can thrive in their endeavours we run the risk of destabilising that pipeline of talent. Women are most likely to leave research during those early years of their career, often termed the "leaky pipeline".

2.4 Aligning higher education with skills needs for a successful economy makes sense. In 2018 SFI launched the SFI Centres for Research Training (CRTS) programme. The purpose of the SFI CRTs is to build on research excellence and to provide cohorts of academically outstanding future research leaders with the skills and knowledge required to address the future challenges of an ever-changing work environment. We are currently funding six CRTs that will train a total of 700 PhD students in the area of Data and ICT Skills for the future. It is our ambition that budget will be secured to run future iterations of this programme.

2.5 It is our firm belief that investment in higher education is required as a key enabler of Ireland's position as a knowledge-based economy, a leading innovator, a resilient society and a vital contributor to the European higher education and research area. Investment in higher education is an investment in the individual and our society. SFI warmly welcomes the announcement of the HEA capital infrastructure programme. Without such commitments Ireland is vulnerable to falling behind other countries. Such investment, coupled with the actions presented under the policy consultation report on progressing a Unified Tertiary System for Learning, Skills and Knowledge will lead us to a position of a more balanced and fair education system which places the learner at the centre and takes advantage of our collective strengths.

Suggestions for future action

- SFI welcomes the current DFHERIS review of state supports for PhD researchers and recommends a sense of urgency around the outputs of that process
- SFI welcomes the capital infrastructure programme and recommends that appropriate balance is sought to support infrastructural and indirect costs of research, *and* to support the allocation of academic time to scholarship and preliminary and exploratory research
- The identification of the high-level (PhD and postdoctoral) skills required for the future and creating a national talent roadmap to meet those needs would be a powerful exercise which will help to secure our ability to respond to future societal, public service and economic needs.
- SFI recommends that additional funding be provided specifically for cohort doctoral programmes, such as the highly successful SFI CRT Programme.
- SFI recommends that an explicit objective of increased investment in higher education be to attract, retain and develop outstanding research talent and to ensure the diversity of that talent.

3. Female Participation, Diversity and Inclusion in STEM

3.1 The demands for those with STEM skills is accelerating and is projected to continue on an upward trajectory with demand expected to grow by around 8% between now and 2025 – compared to expected average growth of 3% for all occupations. Employment in STEM related sectors is also expected to rise by ~6.5% between now and 2025. Everyone should have an opportunity to benefit from these career opportunities.

3.2 A recent report issued by the World Economic Forum showed that as technology continues to replace human activity, and as STEM careers grow, it is women who will be most affected because of their low participation in STEM professions. The reports notes that women stand to gain only one new STEM job for every 20 lost across other job families, whereas the ratio for men is one new job for every four lost elsewhere.

3.3 It remains a fact that women and girls are underrepresented in several areas of STEM. Fewer girls take up most STEM subjects including physics, engineering, applied maths and computer science. Many girl's schools offer a reduced range of STEM subjects.

3.4 Data from 2019 shows that only 68% of girl's schools offer science subjects other than maths and general science compared to 94% of boy's schools. At 3rd year only 27% of girls take a STEM subject other than maths or general science compared to 73% of boys. An iWish survey in 2021 revealed that over three-quarters of teenage girls cite lack of subject choices as a barrier to a career in STEM. Chemistry and Biology are the only two subjects where there are more females than males sitting the Higher Leaving Certificate exam. In all other STEM subjects, there are more males than females sitting the higher paper.

3.5 There are several reasons for this ongoing imbalance. A lack of role models for girls and women and bias and stereotypes are strong contributary factors. Through the above-mentioned programmes such as Curious Minds and ESERO Ireland, the SFI Discover Programme and the work of the SFI Research Centres we are actively trying to turn this tide at primary and secondary level.

3.6 SFI has been at the forefront in developing initiatives to remove and mitigate any existing or perceived factors that may limit the participation of women in STEM careers at fourth level. The agency has introduced initiatives to across a range of funding programmes which have resulted in significant improvements in the representation of women in STEM. For example, in 2019, SFI introduced a range of gender initiatives in the SFI Frontiers for the Future Programme to increase the number of women awardees. After these gender initiatives were implemented, the percentage of women funded increased from 21%, in previous equivalent programme calls, to 45% in the FFP 2019 call.

3.7 Increasing the number of women in STEM will have an impact for the younger generations as we grow our pool of role models and break the stereotypes. SFI has been collecting and analysing data on application submission and success rates by gender since 2011. These data (consolidated in SFI's Gender Dashboard) have enabled us to examine success rates and funding amounts across SFI's portfolio of grants and to expose any unintended biases which may exist between the genders (binary) in the review process. SFI recognises that it is imperative that diverse perspectives inform STEM research in Ireland in order to progress and develop solutions for the many challenges we face. The agency is in the process of developing an Equality, Diversity and Inclusion strategy and associated implementation plan. SFI welcomes the Programme for Access to Higher Education programme and will look to align with that programme under the EDI strategy and implementation plan, as appropriate.

3.8 Last year the findings of a Government of Ireland campaign, Creating Our Future were published. Over 18,000 submissions were received, analysed and synthesised into 16 thematic areas. Reimagining learning and development across the life course was identified as an area of significant interest. A call for reform featured strongly, whether at early years, Leaving Certificate or in how we deliver postdoctoral education. Many submissions provided suggestions for curriculum additions across different levels of education including in critical thinking, scientific logic/thinking, problem solving etc. See Appendix B for further detail on this Creating Our Future theme.

Suggested future actions

- Ensure that STEM Education Implementation Plan actions towards improving gender balance, equity and inclusion are supported across all stages of learning, with regular monitoring to continue informing policy.
- A consolidated approach to data collection which allows us to understand the diversity of our research base and to ensure that it is representative of Irish society and can deliver solutions for society's needs.
- Policy makers and those involved in curriculum development should look to the findings of Creating Our Future so that they may consider the views of the public in this regard.

4. Digital Strategy to Support STEM

4.1 SFI is funding research in areas that are providing the skills and innovation to enable our country to prosper in a digitised world. We are doing this through our PhD training programmes, the world leading SFI Research Centres along with our individual led programmes of research and more recently established National Challenge Fund, are looking at the areas of research for our changing world.

4.2 All of the above activity is creating a critical mass of expertise and innovation that can support and inform all aspects of our society and public services – including the education sector. The research community are already supporting the sector through their programmes of engaged research and outreach programmes.

Suggested future actions

- SFI warmly welcomes and supports the introduction of the D/FHERIS Evidence for Policy Unit and associated Civil Service Management Board approval of a proposal to establish Civil Service Research Network (CSRN). The body has the potential to create a meaningful path for engagement between policy makers and the academic community. The outputs and associated actions of the consultation on the sourcing of science advice, led by the Department of Further and Higher Education, Research, Innovation and Science, have the potential to create deeper connections between the research community and policy makers – thus creating more prospects for leveraging the outputs of publicly funded research for the benefit of public service.

Appendix A - Creating our Future Findings

3.2.2 | Reimagining learning and development across the life course

Learning and development emerges from the submissions as an area of significant interest. This is a very broad theme focusing on education at all levels, from early years through to postgraduate education, as well as lifelong learning. The call for 'reform' features strongly, whether at early years, Leaving Certificate or in how we deliver postdoctoral education. Many of the submissions highlight the importance of cultural education and the role of the humanities, while some suggestions focused on the process of learning itself, e.g., '*explore how to teach the general public to do research themselves*'; and '*research how to boost literacy and de-stigmatise the effort to learn how to read and write effectively at a high level whether adult learners or youth.*'

Submissions can be clustered into four main areas according to their focus on:

1. **Early years development**
2. **Lifelong learning and education**
3. **Primary and secondary education**
4. **Higher education**

3.2.2.1 Early years development

Submissions falling under this area cover a mix of specifically early years education, breastfeeding and other issues relating to development and well-being in early to middle childhood. Many relate to health and well-being at a specific point in the human life cycle. Illustrative examples include: a call to research the impact on babies in pushchairs of being faced away from the parent or adult pushing the pushchair, with specific lens on babies' social, emotional and psychological development; to investigate the outcomes of prioritising play above 'learning'; the use of machine learning algorithms to individualise sensory playroom stimulation; and calls to increase breastfeeding and early childhood support in maternity services and in the home, given that stressed parents in the first few years of a child's life can cause lifelong problems, including chronic illness. The question of how we implement and advance the findings from projects such as Growing Up In Ireland[2] and Preparing for Life[3] arose along with how the barriers to implementing the learnings could be better understood and addressed.

Public insights

Many submissions provided suggestions for curriculum additions across the different levels of education:

Health and well-being

- Mental health, meditation, yoga, more physical education, exercise, and nutrition

Life skills

- Financial literacy, pensions, insurance, tax, pay, mortgages, DIY, driving skills, first aid

Community/place

- Nature/outdoors, consent, empathy, the environment, entrepreneurship, circular economy, climate justice

Thinking

- Critical thinking, digital fluency, scientific logic/thinking, philosophy, creative thinking, systems thinking, independent thinking, problem-solving, ethics

2 https://www.growingup.ie/

3 https://www.preparingforlife.ie/

3.2.2.2 Lifelong learning and education

Several submissions highlighted the importance of education for life and indicated concern that the school system is educating people for taking a terminal examination, namely the Leaving Certificate. The argument expressed was that many of the soft skills that people need for life are not getting sufficient coverage in the curriculum.

Key areas that were seen as inadequately covered include physical activity for health, gender, sex, and relationship education, home and personal financial education, digital literacy and digital risk, and Ireland's history of both migration and exclusion and aggression towards those who were or are 'othered'. Submissions touched on apprenticeships and how a focus on trades and associated skills being taught in primary and secondary school might be useful both in terms of life skills and a shift in attitudes towards alternative paths to further and higher education (e.g., apprenticeships). The need to promote and improve attitudes towards learning Irish and foreign languages and to improve how we teach them came through in several submissions.

3.2.2.3 Primary and secondary education

A range of issues were covered in submissions relating to primary and secondary level education. Submissions highlighted the importance of whole-person development beyond just an academic focus; homework and its value, work-life balance for children; the length and type of the school day and week; and the implication of shorter days for Junior and Senior Infants, with specific mention of its impact on gender equality, women in the workplace and on climate.

Submissions also highlighted literacy, numeracy, and digital literacy issues for individuals in the education system as well as noting the importance of video and other digital media, gamification, and technology more generally in education. Concerns about inclusion and poverty were raised in the context of education. These highlighted a desire for better education for immigrants and refugees, school transport for disadvantaged children and the impact of free lunches in schools. Submissions also noted the problems of bullying and of male suicide.

Among the submissions were topics relating to child welfare and rights. Some related to the role of the state (such as Tusla), others highlighted some specific concerns associated with research involving children. In the submissions on primary and secondary education, the importance of teacher training and education in preparing our teachers for a multi-cultural world, and in dealing with children with disabilities and mental health was also highlighted. Some submissions also called for the separation of church and state in our school system.

3.2.2.4 Higher education

The majority of submissions relating to higher education focused on issues of student accommodation and mental health. The educational areas highlighted included the need for more places, equality of provision, and no fees. The need for sustainable quality in the learning experience at higher education was also stressed as were the challenges associated with transitions, both into higher education and from there to the workplace, and the importance of identifying the reasons that account for poor student engagement among some students at third level.

Many submissions suggested the addition of new skills, subjects, and approaches at all levels of education in Ireland, including "life skills". Submissions under this theme expressed a need to rethink the curriculum for today's contexts, needs and behaviours and attitudes. Examples referred to virtual reality, 3D printing, coding and game design that are set to dominate careers in the future, and a need to prepare primary and secondary school students for this world. Also, within the submissions were numerous calls for more yard and outdoor time as done in other countries, with an opportunity to explore ways of incorporating learning into play and physical activity.

Commentary and Calls to Action

There was an overarching sense from some of the submissions that schools in Ireland are 'clinging to the traditional ways of teaching', and there is a need to re-evaluate to ensure it is fit for purpose in the 21st century. Also, the public highlighted that childhood is a time not just for education but for development, and there is a need to re-evaluate the role of education in terms of learning for life – not only skills for jobs as the system is not equipped to prepare young people for living in today's society.

1 **Focus on implanting the findings of existing research conducted in Ireland and internationally.**
For example, the effectiveness and benefits of increased physical and outdoor activities as part of the education curriculum has been widely researched. Research should play a role in identifying the barriers to implementation, co-creating and piloting solutions for the Irish context and then embedding evaluation into any changes implemented.

2 **Integrate findings within existing research efforts in Ireland, which are already working to address many of the concerns raised by the public.**
While this exercise doesn't represent the whole of Ireland, this was a good opportunity to validate some of the existing research under way, e.g., a recent pilot study assessed the feasibility of implementing and evaluating 'Quiet Time' built into the curriculum in two pilot settings in the UK and Ireland.[4]

Further consideration should be given to individual submissions within this theme by those involved in learning and development research and policy, particularly to identify where the public could be involved in their work, e.g., the public is interested in further dialogue on the education curriculum at all levels.

Increased efforts to communicate to the public on existing research may be warranted given the public's interest, and consideration should be given to a national initiative to encourage staff, students, and parents to look critically at current offerings and co-create new approaches. The design thinking approach would suit this challenge.

Insights garnered from this exercise may inform the National Council for Curriculum and Assessment (NCCA) that is currently in the process of a stem-to-stern re-evaluation of second level.

3 **Additional research is required:**

- In languages, particularly the Irish language
- To re-evaluate the role of education in terms of learning for life not only skills for jobs
- To inform the talent and training for skills of the future
- On the future of parenting – several cross-cutting issues were evident in the submissions from maternal health and early childhood development to parental leave, childcare supports and parents' careers. Research is required to determine how Ireland could become the best place to parent.

4 **Develop implementable plans to train, develop, and upskill the teaching workforce and focus on diversifying it.**
Determine if there is a need to bring ethnic, gender, religious and cultural diversity into schools, particularly to disadvantaged areas, so children will identify with staff and the educational environment.

4 https://www.frontiersin.org/articles/10.3389/fpsyg.2021.765158/full

Appendix B Examples of SFI Research Centre Education and Outreach Programmes to support education

Insight, the SFI Centre for Data Analytics

Insight includes in its Education and Public Engagement objectives the ambition to upskill researchers in using a new and exciting environment to introduce their research topics to a school-going population, and to upskill teachers and educationalists in the use and benefit of Virtual Reality (VR) as a learning mechanism. Insight plan to achieve this through their "Immersive Classroom Research Experience". This EPE Activity introduces teachers to the value of VR as an engaged learning environment that captures the imagination of young participants. VR is an interactive resource where participants, through avatars, are able to engage directly with other users and their surroundings. Insight has been using VR since 2019 as an environment for upskilling teachers and developing a new way for researchers to present their research projects to a school-going population.

ADAPT, SFI Research Centre for AI-driven Digital Content Technology

In 2021 and 2022, ADAPT's All Ireland Linguistics Olympiad (AILO) programme enabled 6,000 secondary school students (25% from disadvantaged schools) to hone the creative problem-solving skills that underpin AI and related STEM fields. Evaluation of the Olympiad reveals strong outcomes in terms of students' lateral-thinking skills and self-efficacy related to problem solving, and propensity to consider further studies at the intersection of computing, linguistics and language. AILO is therefore delivering impact by contributing to

Appendix C – SFI Discover Programme Case Study

STEM Passport for Inclusion

Through the SFI Discover Programme and in partnership with the Department of Education, we are supporting the STEM Passport for Inclusion Project. Led by Dr Katriona O'Sullivan at Maynooth University, the project addresses gender inequalities among female pupils in socially disadvantaged communities through an innovative programme of mentoring and education supports. The STEM Passport for Inclusion offers female secondary school students the opportunity to graduate with a university-accredited STEM skills module, and to develop a meaningful mentoring relationship with women in Industry. Recent research conducted by Maynooth University has shown that 16% of female students were not studying a science subject at Higher Level for the Leaving Certificate, while 6% of female students do not have the opportunity to study STEM subjects at Secondary level. The initiative provides a platform for girls to understand, participate and celebrate STEM, in order to increase STEM awareness and create pathways to further and higher education in STEM. The STEM Passport for Inclusion programme was co-designed by the education leads at Microsoft Ireland and Maynooth University and is delivered by Microsoft's Dream Space team at its campus in Leopardstown, Dublin, and in the RDI Hub in Kerry. The national programme will empower 5,000 Transition Year girls from unrepresented communities to gain a Level 6 STEM qualification, which may not otherwise be available to them, and go on to apply for STEM courses at Maynooth University, Munster Technological University and Atlantic Technological University.

NPC submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science: "The Future of STEM in Irish Education"

1. **STEM in Primary Education**
   The majority of parents are aware that their child learns about maths and science in school (98% and 65% respectively), only 17% and 8% are aware of their child learning about Technology and Engineering respectively.
2. **Supporting Children's STEM Education**
   The majority (79%) of parents report that their child is interested in and excited about learning about STEM subjects in school. However, the most common response to what nurtures this excitement, were the child's own interest in and enjoyment of STEM subjects (68%). Only 21% of parents said that their child's teacher seems passionate about STEM subjects. 15% of parents felt that their child's teachers "*access to the materials and upskilling needed to teach STEM subjects*" supported their interest. Parents identified things like opportunities for "*designing & making things at school*" (66%) and "*being supported and encouraged to imagine, question, be curious and explore objects and ideas*" (53%) as things that would further support their child's STEM learning. 51% of parents said having a teacher who seems passionate about teaching STEM would support their child's engagement. 49% of parents felt that their child's teacher having access to the materials and upskilling needed to teach STEM would support their child's STEM education
3. **Children's Understanding of STEM Careers**
   Currently, 57% of parents think their child does not have a good understanding of STEM careers, and 24% do not know if they do. Of the parents who felt their child does have a good understanding (19%), most pointed to family members or friends who work in the area of STEM as the reason for this understanding (67%). When asked what they felt would support their child's understanding of STEM careers, 73% of parents felt that informal conversations in class would help, while 66% felt that it would be important for STEM careers to be represented in their child's books such as English and Irish readers, Art lessons, History and Geography books.
4. **Parents Understanding of STEM Careers**
   Only 33% of parents surveyed felt that they knew enough about STEM subjects, careers and how to support their child's STEM learning. The majority of this cohort of parents (89%) said this was due to their own understanding of STEM. Only 6% said that their understanding was due to training sessions in their child's school on how they "*can support their STEM learning, including the activities they already do at home that support their child's STEM learning*". 11% of parents felt that "information sessions on the skills learned from STEM education including how those skills support their learning in other subjects and the further study and careers that are possible with those skills" had supported them. 67% of parents would like to be supported with *"informational material on what STEM education is"*. 60% of parents felt that they would be supported by *"Information sessions on the skills learned from STEM education including how those skills support their learning in other subjects and the further study and careers that are possible with those skills"*. 50% of parents said "*Training sessions in my child's school on how I can support their STEM learning"* would help them to better support their child's STEM learning.
5. **Extra-, and Co-Curricular Activities**
   The majority of parents (61%) said that their child does not learn about and experience STEM subjects outside of their classroom learning. Of the parents who state that their child does learn about and experience STEM subjects outside of their classroom learning 29% say this is through "*after school clubs for STEM interests*" and 25% state that their child "*visit STEM industries and businesses and class talks with members of the STEM community*". When parents were asked what outside-of-school activities they thought would support their child's STEM learning 80% answered that "*after school clubs for STEM interests*" would support their child, and 66% state that *"visits to STEM industries and businesses and class talks with members of the STEM community"* would help their child's STEM learning
6. **Digital Technology**
   When asked about the digital technology in their child's school, 55% of parents either did not think that their child's school had the digital technology and equipment needed to support STEM learning (23%) or

did not know if it did (32%). 46% of parents felt their child's school did have the digital technology and equipment needed to support STEM learning. Parents were asked about a number of technologies that their child's school has, or that they would like their child's school to have. The majority of parents said that their child's school has a range of devices available (88%). The biggest discrepancy between the resources schools have, and what parents think should be available was in relation to "*technology, coding, or programming classes*": 12% of parents said that their child's school currently offers technology, coding or programming classes, but, 78% of parents feel that classes in technology, coding or programming would support their child's STEM learning

7. **Additional Comments**
   Parents had the opportunity to add comments throughout this survey, some of the topics included:
   - Access to high quality curriculum materials showing a range of people of all genders, abilities and backgrounds taking part in STEM learning and careers,
   - Improved teacher education and capacity, and the importance of having teachers who are passionate about STEM education,
   - The opportunities for increased parental engagement through more communication about STEM subjects and careers, as well as parents who work in STEM coming in to talk to children about their work, or running experiments etc with children
   - Partnerships between their child's school and the wider STEM community,
   - Improved funding for STEM education,
   - Secular education.
   - All comments can be read in Appendix 1.

8. **<u>STEM in Post-Primary Education</u>**
   Most parents of Post-Primary aged children who responded to the survey are aware of their child learning about Junior Cycle Science (90%) and Honours Maths (55%). Only 21% of parents said that their child is studying Technology in school, while only 11% say their child is learning about Engineering.
9. **Supporting Children's STEM Education**
   The majority of parents (70%) say that their child is interested in and excited about STEM learning. Similar to the Primary survey, the most commonly identified factor which supports this, is children's own interest in and enjoyment of STEM learning (76%). Only 17% of parents say that their child "*gets the opportunity to test out their ideas and make changes if needed"*, and 22% of parents say that their child's teachers have "*access to the materials and upskilling needed to teach STEM subjects"*. Parents identified things like "h*aving teachers who are passionate about teaching STEM subjects*" (65%), "*being supported and encouraged to imagine, question, be curious and explore objects and ideas*" (61%) and "*In-school exercises and activities that show all types of people learning about and working in STEM, so that my child know they can study or work in STEM no matter what their ability, background or gender*" (61%)
10. **Children's Understanding of STEM Careers**
   Three-quarters (76%) of parents either do not think their child has a good understanding of STEM careers (50%), or do not know if they do (26%). Similar to the Primary survey, of the parents who felt their child does have a good understanding of STEM careers (25%), the majority of them identified family members or friends having careers in STEM as the main reason for this understanding (60%). 34% of parents feel that their children's understanding of STEM careers is supported by their teacher talking about STEM careers in class. The majority of parents (86%) feel that their children's knowledge of STEM careers would be supported by "Going to STEM fairs, festivals or careers days" and 76% say that "informal conversations in class about STEM careers" would be beneficial.
11. **Parents Understanding of STEM Careers**
   As with the parents in the Primary survey, only 34% of parents surveyed felt that they knew enough about STEM subjects, careers and how to support their child's STEM learning. The majority (60%) said this was due to their own understanding of STEM, or a personal interest in STEM Education (60%). Only 3% said that their understanding was due to information sessions in their child's school on how they "can support their STEM learning, including the activities we already do at home that support my child's STEM learning". Only 7% of parents felt supported by "information sessions on the skills learned from STEM education including how those skills support their learning in other subjects and the further study and

careers that are possible with those skills" had supported them. 79% of parents felt that they would be supported by "information sessions on the skills learned from STEM education including how those skills support their learning in other subjects and the further study and careers that are possible with those skills" would help them to better support their child's STEM learning. 60% of parents would like to see "informational material on what STEM education is" as a support for them.

12. **Extra-, and Co-Curricular Activities**
    The majority of parents say that their child does not learn about and experience STEM subjects outside of their classroom. Of the 31% who said that their children do engage in extra-curricular STEM learning, the most commonly identified area for this learning was in after school clubs for STEM interests (38%). 80% of parents felt that "school trips to STEM festivals and fairs", and 79% felt that "visits to STEM industries and businesses" would support their child's STEM learning.
13. **Digital Technology**
    52% of the parents who responded to the Post-Primary survey felt that their child's school had the digital technology and equipment needed to support STEM learning. 28% felt that their child's school did not have the digital technology and equipment needed to support STEM learning, and 20% said they did not know. Parents were asked about a number of technologies that their child's school has, or that they would like their child's school to have. The majority of parents (92%) said that their child's school has a range of devices available. Similar to the results from the Primary survey, the biggest discrepancy between the resources schools have, and what parents think should be available was in relation to "technology, coding, or programming classes": 34% of parents said that their child's school currently offers technology, coding or programming classes, but 76% of parents feel that classes in technology, coding or programming would support their child's STEM learning. 78% of parents felt that high quality broadband would be an important support for children's STEM learning.
14. **Additional Comments**
    Parents had the opportunity to add comments throughout this survey. Some of the comments included:
    - Communication with parents, so that they know what STEM subjects are, how to support STEM learning, and what STEM careers options are,
    - Giving children opportunities to learn STEM subjects through experiments, not just textbooks,
    - Collaboration with STEM companies to support STEM development
    - The importance of having enough teachers who are trained to teach STEM subjects
    - Having access to relatable, diverse role models,
    - Improved funding for STEM education,
    - All comments can be read in Appendix 2.

<u>**Female Participation, Diversity and Inclusion in STEM**</u>

16. <u>Female participation in STEM</u>

Primary

The majority of parents felt that their daughter's gender (60%) has not had an impact on her STEM education so far. Supports such as: all genders being represented in their child's learning materials (57%) , girls being encouraged to play with toys that promote STEM learning such as Lego, robots, video games, science kits etc (55%), and girls' interest and achievements in STEM subjects being encouraged and praised (51%) were some of the ways that parents felt their daughter's gender had positively impacted her STEM education so far. Of the 3% of parents who felt their daughter's gender had negatively impacted her STEM education so far, 41% of parents said that their daughter does not have access to any, or all, of the STEM subjects in her school, and 41% said their daughter does not have any female role models to look up to in the field of STEM learning. The majority of these parents (80%) said that access to female role models in STEM and girls being encouraged to play with toys that promote STEM learning (80%) would support their daughter's STEM education. It should be noted that 34% of parents did not know if their daughter's gender had had an impact on her STEM education so far, and 3% of parents felt her gender had positively impacted it.

17. **Post-Primary**

The majority of parents (56%) felt that their daughter's gender has not had any impact on her access to STEM education so far. Of the 13% of parents who felt their daughter's gender had negatively impacted her access to STEM education, the majority of parents said that their daughter does not have access to Engineering (67%) or Technology (60%) in her school 40% of parents said that their daughter does not have any female role models to look up to in the field of STEM learning. When asked what would support their daughter's STEM learning, 67% of parents said "girls being encouraged to take part in STEM competitions and events for girls"

18. Diversity in STEM

Primary

Most parents (56%) stated that their child's background has not had an impact on their STEM education so far. Parents identified policies and practices such as: "all children being encouraged to play with toys that promote STEM learning" (47%) and "teaching materials that show people of all backgrounds, nationalities etc taking part in STEM learning and careers" (38%) as ways their child's school ensures that children's backgrounds do not negatively impact their STEM education. Of the 36% of parents who felt that their child's background has had an impact on their STEM education so far, 26% of parents stated that their child does not have access to any, or all, of the STEM subjects in their school and 19% feel that their child does not have diverse role models to look up to in the field of STEM. The majority of parents who feel their child's background has had an impact on their STEM education so far (70%) felt that all children being encouraged to play with toys that promote STEM learning would support their child's STEM learning and 67% of parents would like to see more accessible after school clubs and activities for their child.

19. Post-Primary

One-third (30%) of parents say that their child's background (where they are from or religious beliefs etc) has had an impact on their STEM education so far. 24% of these parents say their child does not have access to any, or all, of the STEM subjects in their school, and a further 24% said that their child does not have any diverse and inclusive role models to look up to in the field of STEM learning. When asked about supports, practices and policies in their child's school that helps ensure that children's background does not negatively affect their STEM Education, 35% of parents say that all children's interest and achievement in STEM subjects is encouraged and praised, while 26% said that their children's teaching materials show people of all backgrounds, nationalities etc taking part in STEM learning and careers. When asked what would support their child's STEM learning, 73% of parents said "all children's interest and achievement in STEM subjects being encouraged and praised"Inclusion in STEM

Primary

65% of parents stated that their child's ability has not had an impact on their STEM education so far. When asked about supports, practices or policies in their child's school that prevents their child's ability negatively impacting their STEM education 52% stated that all children are encouraged to play with toys that promote STEM learning, and 33% stated that their child's learning materials show people of all abilities and with all bodies learning about and working in STEM. Of the 23% of parents felt that their child's ability has had an impact on their STEM education so far, 36% of parents stated that their child does not have access to any, or all, of the STEM subjects in their school and 24% stated that their child does not have any diverse and inclusive role models to look up to in the field of STEM learning. The majority of parents who feel their child's background has had an impact on their STEM education so far (71%) felt that all children being encouraged to play with toys that promote STEM learning would support their child's STEM learning and 61% of parents would like to see more accessible after school clubs and activities for their child.

In relation to children with Special Educational Needs, some parents felt that a plan should be drawn up specifically for STEM education in Special Schools. Other parents noted that sometimes the gap between the support their child gets and what they would need to fully participate in STEM learning is prohibitive. Finally, parents of gifted children, or children who have a particularly keen interest in certain STEM subjects noted that they do not think their child's needs are met, as their child is beyond the level being taught in their current class.

20. Post-Primary

A quarter of parents (24%) feel that their child's ability (like Special Educational Needs, a disability or a medical condition) has had an impact on their STEM Education. 26% of these parents say that their child doesn't currently have access to any, or all, of the STEM subjects in their school, while 21% of parents say that their child's interest and ability in STEM subjects is not encouraged as much as the other children in their classes. When asked about supports, practices and policies in their child's school that helps ensure that children's different abilities does not negatively affect their STEM Education, 44% of parents say that all children's interest and achievement in STEM subjects is encouraged and praised, while 30% said that their children's teaching materials show people of all backgrounds, nationalities etc taking part in STEM learning and careers. When asked what would support their child's STEM learning, 62% of parents said "access to inclusive role models in STEM"

21. Recommendations

i. Whilst the data is very rich, there are some emerging themes which warrant further exploration, some themes outlined below we believe could form the basis of some initial recommendations:
ii. Parents strongly identified children having the opportunities to design and make things at school as something that would support their child's STEM education. Ensuring that schools have access to the materials and resources for practical learning such as conducting experiments and making models etc, so that children have the opportunity to engage in STEM learning in this way is very important.
iii. Parents also identified the many ways in which they could work in partnership with their child's school to support children's STEM education, such as, increased two-way communication about children's interests and abilities in STEM, information for parents on STEM subjects and careers, and opportunities for parents who work in STEM to come in to classes to talk to children about their work, or run experiments etc,
iv. Research has indicated that parents have a big influence on children's, particularly girls, subject choices and careers in the area of STEM, with almost two-thirds of girls (65%) saying their parents are most likely to influence subject choices at school, and half saying their parents influence their career aspirations. (Accenture Ireland and I Wish, 2017). Therefore, providing parents with the information and guidance they need to feel equipped and able to support their child's STEM education and career choices is crucial if we are to encourage more children and young people to study STEM subjects and pursue careers in the area.
v. Parents consistently highlighted the important role that teachers play in supporting their child's STEM learning. Parents identified providing teachers with the initial education and ongoing upskilling, as well as ensuring they have access to the high-quality teaching materials and resources, they need to be fully supported to implement STEM learning in a passionate way in their classrooms as vitally important.
vi. Ensuring access to afterschool STEM clubs and "technology, coding or programming classes" were clearly identified as things parents felt would support their child's interest and learning in STEM.
vii. In relation to female participation, diversity and inclusion, parents consistently identified having a range of role models of different genders, abilities and backgrounds, having access to all STEM subjects in their schools, having accessible after-school clubs and schools encouraging all children's interest and achievements in STEM as factors that would support their children's STEM education.

22. Executive Summary

- 4261 parents responded to National Parents Council Primary surveys on STEM Education in Primary and Post-Primary Education.
- Most parents of children in both Primary and Post-Primary school feel that their child is interested in and excited about learning STEM subjects, however, most feel this is due to children's own interests rather than factors relating to the teaching and learning of STEM subjects in schools.
- The majority of parents feel that both they and their children are lacking an understanding of STEM careers.
- While the majority of parents do not feel that their child's gender, background or ability has impacted their STEM education so far, it should be noted that:
    - 3% of parents of children in Primary and 13% of parents of children in Post-Primary school feel that their child's gender has had an impact on their STEM education so far,
    - 36% of parents of children in Primary and 30% of parents of children in Post-Primary school feel that their child's background has had an impact on their STEM education so far, and,
    - 23% of parents of children in Primary and 24% of parents of children in Post-Primary school feel that their child's background has had an impact on their STEM education so far.

2023/041

INTO Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

The Future of Science, Technology, Engineering and Mathematics (STEM) in Irish Education

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Introduction

The Irish National Teachers' Organisation is the oldest and largest teachers' trade union in Ireland. It represents almost 50,000 teachers at primary level in the Republic of Ireland and primary and post-primary level in Northern Ireland. The INTO would like to thank the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science for the opportunity to discuss the Future of Science, Technology, Engineering and Mathematics (STEM) in Irish Education.

In January 2022 the INTO made a submission to the Department of Education as part of the Department's Consultation of Phase 2 of the STEM Education Implementation Plan.

The Department of Education's STEM Education Policy Statement (2017–2026) provides a national focus on STEM education in 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 further to the consultation and discussion around STEM Education.

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 STEM subjects. 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 throughout their primary and post-primary school education.

Such is the rapid pace of change and technological developments that it is predicted 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 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) provide a benchmark against which to gauge our STEM education outcomes. The TIMSS 2019 study stated that at fourth class level, out of the 22 participating European Union (EU) member states/territories, no EU countries ranked above Irish students in Mathematics. Irish primary school pupils ranked 8th out of all 50 countries participating. Irish students ranked 5th in science out of the 22 EU participating member states/territories and 13th out of all 48 countries participating. These results reflect a stable performance since TIMSS 2015.

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

The Irish Primary School 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 primary school should nurture this curiosity and allow them to ask questions and develop the skills they need to find an answer. Primary school science currently 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.

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 pupils. 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.

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"*.

Primary Curriculum Developments

Our current Primary Curriculum is the oldest in Europe and the process of developing a new Primary Curriculum Framework is underway. The Framework envisages that the Primary Curriculum will be presented in five broad curriculum areas, one of which will be STEM.

STAGES 1 AND 2 (JUNIOR INFANTS - 2ND CLASS)	LANGUAGE (IRISH AND ENGLISH)	MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION	WELLBEING	ARTS EDUCATION*	SOCIAL AND ENVIRON-MENTAL EDUCATION	RELIGIOUS/ ETHICAL/ MULTI-BELIEF EDUCATION - PATRON'S PROGRAMME
STAGES 3 AND 4 (3RD - 6TH CLASS)	IRISH ENGLISH MODERN FOREIGN LANGUAGES	MATHEMATICS SCIENCE AND TECHNOLOGY	PHYSICAL AND HEALTH EDUCATION SOCIAL, PERSONAL AND VALUES EDUCATION	VISUAL ARTS MUSIC DRAMA (AND OTHER ASPECTS, E.G. DANCE, FILM AND DIGITAL MEDIA)	HISTORY GEOGRAPHY	RELIGIOUS/ ETHICAL/ MULTI-BELIEF EDUCATION - PATRON'S PROGRAMME

Mathematics, Science and Technology Education supports children's capacity to understand and engage fully with the world around them. Mathematics provides the foundation for science and technology. Science and technology are intrinsically linked and enable children to benefit from learning about, and working with traditional, contemporary and emerging technologies. They also enable children to develop an interest in and understanding of the biological, material and physical world by exploring and investigating scientific concepts and processes (NCCA 2020).

During an INTO consultation with members on the Draft Primary Maths Curriculum in 2022, some members expressed concern at the grouping of mathematics with science, technology and engineering. Teachers emphasised the importance of ensuring that sufficient, distinct time is allocated to Mathematics due to the crucial importance of the development of foundational numeracy and maths skills in the early years of primary school (INTO 2022).

Recommendations for the Future of Primary STEM

Class Size: Large classes at primary level are a barrier to the successful implementation of any curriculum subject. The nature of STEM is such that it demands discovery-based learning and inquiry-based, constructivist pedagogies. A reduced pupil–teacher ratio is a prerequisite for such active pedagogies. While the staffing schedule for primary schools has reduced by one pupil per mainstream teacher for the last three years, Ireland's primary school classes remain three pupils per class above the EU average. We must continue to lower class size in Ireland.

Funding for Schools: There is a need to support schools in the reimagining of creative spaces where STEM education methodologies and STEM based learning can thrive. Creative spaces should be provided in all schools and resourced accordingly. For this, increased investment in primary education is essential.

Continuous Professional Development: It is imperative that both practicing, and student teachers are provided with the training and Continuous Professional Development (CPD) to upskill in the ever-evolving area of STEM education. The INTO recommends that CPD for STEM should be provided on a continual, planned and well-resourced basis, focussing on a whole-school approach which supports a school's local context, environment and interests.

School Leadership/ Posts of Responsibility: The full restoration of middle-management posts in primary schools would afford them the opportunity to delegate STEM-related preparation for teaching and learning (including the organisation of whole-school projects and activities) to an in-school management team member.

Integration: Whilst the 2020 STEM report promotes integrated experiences of STEM education to enhance pupils' learning experience, the challenge that this poses curriculum delivery is recognised. The Draft Primary Curriculum Framework, recently approved by the Minister, seeks to support a more integrated approach to teaching and learning. The NCCA and other stakeholders must bear this in mind in the development of a coherent curriculum.

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. 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). Sufficient investment must be provided to develop outdoor spaces in schools to facilitate the interdisciplinary nature of STEM.

Links with the Community: Strong links with local industries, educational institutions and community groups are effective in enriching STEM education at school level. Opportunities for schools to support community efforts in advancing local projects across early childhood, primary and post-primary curricula should be promoted. INTO is currently undertaking research on transitions from early years settings to primary school and the area of STEM offers an opportunity for both settings to work collaboratively.

Gender Equity: Gender stereotyping, curriculum accessibility and resourcing are all contributory factors to Ireland's high gender differential between male and female STEM graduates. Gender-responsive STEM education must be encouraged to provide all children and young people with scientific and technical knowledge and skills that can be applied to real-life contexts, strengthen agency, and enable critical understanding of 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 INTO welcomes the NCCA's recent consultation with children and young people on STEM. In preparing for the teaching and learning of STEM, pupils' interest and prior knowledge must be considered and their active participation encouraged.

Artificial Intelligence (AI) Skills/Assistive Technology: Information and communication technology has brought profound changes to all aspects of our lives. While the European Commission considers it paramount that children learn about AI from an early age, the 2022 Report on AI skills notes that while almost everyone will need some knowledge or understanding of AI as it becomes embedded into our lives, high-level, technical, AI skills will be needed only by a minority of people. To support the skills needed *"educators will need to be ahead of the curve"*. Schools will be required to deliver a grounding in digital skills across the board and must be resourced and supported to do so.

INTO also notes that the use of assistive technology has contributed to a transformation of the learning experiences of children with special educational needs (SEN). INTO believes that in an increasingly digitised world, enhanced access to assistive technology for pupils with special educational needs is paramount to support inclusion.

Conclusion

STEM subjects are relevant in our everyday lives, accentuating the need to ensure effective education in this area from outset in early years education. During the Covid-19 crisis, young people demonstrated their STEM knowledge and skills to assist their communities. In some post-primary schools across the country, students, for example produced much-needed PPE. This work shows that an integrated approach to science, technology, engineering, and mathematics can have a positive impact on our lives. As the world we live in continues to 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 the tools to empower their pupils. 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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Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

Written Submission from Minister Norma Foley, Department of Education re STEM Education in primary and post-primary schools as requested for the Committee's examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

1. Introduction

STEM and digital education at primary and post-primary schools focuses on developing a range of key skills that are essential for living and working in today's world. This requires the provision of systematic support for primary and post-primary schools from the Department of Education and from the broad range of stakeholders with an interest in STEM and digital education. It will require strong leadership in schools, to foster creativity in learning and to support the growth of a culture of scientific and technological innovation.

STEM and digital education is also supported by ongoing education reforms to provide our learners with a STEM and digital experience that is relevant, meaningful, enjoyable and appropriately challenging. The promotion of STEM and digital learning within our education system is a key priority for the Department of Education, and is reflected in multiple strategy documents, such as the STEM Education Policy Statement, Digital Strategy for Schools, Action Plan for Education, Ireland's National Skills Strategy, Arts in Education Charter, and the National Strategy: Literacy and Numeracy for Learning and Life.

2. STEM Education Policy Statement 2017–2026

The STEM Education Policy Statement 2017–2026, is for all learners from early learning and care settings, primary and post-primary schools. It sets out the roadmap for STEM Education, with ambitious goals and actions that are required to achieve and improve the STEM education experience and outcomes for all learners, and to support learners to progress to STEM pathways in Further or Higher Education.

The STEM Education Implementation Plan 2017-2019 was published alongside the Policy Statement. It built on a range of reforms and initiatives that were already underway in STEM, in areas such as curriculum and assessment reform, teacher professional development, embedding digital learning and advances in initial teacher education. It focussed on establishing what is necessary to provide a quality STEM education experience for all learners

In order to sustain a supportive STEM education eco-system, all stakeholders need to work together to develop a connected learning network. The importance of this collaboration is reflected in the STEM Education Implementation Advisory Group which is tasked with overseeing the implementation of the Policy Statement. The group has representatives from early learning and care, primary and post-primary schools, further and higher education, business/industry, the arts, the fields of STEM, the Department of Children Equality, Disability, Integration and Youth, along with representatives across relevant areas of the Department of Education. The Implementation Advisory Group is supported by number of subgroups which were established in order to give a particular focus to a number of key areas i.e. the Gender Balance in STEM Advisory Group, the STEM and the Arts Advisory Group and the Business/Industry Advisory Group.

The collaboration across these stakeholders and the wider education partners and stakeholders will ensure that Ireland is better prepared to enable our people to succeed and our economy to prosper.

The areas for policy development and action, as identified in the Policy Statement, span four pillars;

Pillar 1: Nurture Learner engagement and participation;
Pillar 2: Enhance early years practitioners and teachers capacity
Pillar 3: Support STEM Education Practice; and
Pillar 4: Use Evidence to support STEM education.

Enhance early years practitioners and teachers capacity;
Notwithstanding the disruption due to the Covid-19 pandemic, substantial progress has been made in many areas of the Policy Statement to date, some of which are as follows;

- STEM related curricular reform to include; Primary Mathematics, Junior Cycle Mathematics, Leaving Certificate Applied Mathematics, Leaving Certificate Art, Leaving Certificate Agricultural Science and Leaving Certificate Computer Science
- Development of a Continuous Professional Development (CPD) Framework which supports the cross-sectoral design and delivery of STEM CPD
- Provision by the Department's professional development support services of opportunities for primary and post-primary teachers to develop STEM learning
- Ongoing funding and support of informal STEM education for primary and post-primary such as BT Young Scientist and Technology Exhibition, ESB Science Blast and SciFest
- Three year School Excellence Fund to 2022, with thirty Digital and ten STEM clusters, comprising circa 200 primary and post-primary schools, with links to external agencies including business/industry and higher education.
- A dedicated section within Scoilnet (central repository for teaching resources) covering STEM with links to Irish and International resources across STEM which are tagged to specifics of the curriculum across primary and post-primary
- A dedicated satellite website www.compsci.ie has been developed to support the roll out of the Computer Science subject for the Leaving Certificate.
- A literature review to identify effective interventions that address key barriers, and build critical assets and skills, in relation to STEM and the Arts learning from early learning and care to post-primary education
- Guidelines in relation to forming business/industry –school partnerships
- STEM awareness campaign for post-primary in conjunction with Science Foundation Ireland
- Partnership between Department of Education and Science Foundation Ireland, with the contribution of €1.3m by the Department to date towards successful projects under the SFI Discover Programme

3. STEM Education Implementation Plan to 2026

The STEM Education Implementation Plan to 2026, developed by the Department of Education and the Department of Children, Equality, Disability, Integration and Youth, is to be published shortly. The actions identified in the Implementation Plan take into account the findings of the review of the implementation to date and the consultation process which was carried out in 2022.

The consultation process identified a number of challenges to the provision of quality STEM education within our schools. These included the gap in understanding of what integrated STEM looks like at primary level, the value put on STEM within the schools and external evaluations and the limited capacity in the provision of STEM subjects in post-primary schools. It also identified the need to provide additional support to educators in relation to their STEM content knowledge, particularly in relation to subjects where there is a shortage of staff, and the challenges in relation to ensuring that student teachers have opportunities to teach a STEM lesson while on placement.

The two Departments will lead on the programme of work and will work with all STEM education stakeholders to address the challenges identified and realise the ambitious actions. Actions include;

- Increase equitable access nationwide to meaningful STEM/STEM and the Arts role models and career awareness activity
- Provision of coherent careers and skills information resources in relation to all learning options for those entering tertiary education, and entering and transitioning within the workforce
- Develop STEM subject and career information sheets for primary school children and their parents/guardians that can be provided in advance of the critical transition to post-primary school
- Support the STEM Passport for Inclusion, led by National University of Ireland, Maynooth, which recognises the experiences of girls from DEIS post-primary schools as they achieve micro-credentials in STEM, through mentoring and engagement with STEM content knowledge
- Ensure all programmes of teacher education and post-graduate guidance counselling programmes across the continuum include awareness raising training on the barriers to participation of underrepresented groups in STEM and the role of teachers in helping remove these barriers
- Develop professional learning opportunities to support teachers and guidance counsellors in raising awareness of STEM subject choices and STEM opportunities, signpost labour market information and promote the diversity in STEM pathways and careers
- Support existing pre-service and in-service teacher internships as a facility for student teachers/teachers to experience STEM as it is applied in the workplace
- Provision of a central repository to include resources and exemplars of STEM/STEM and the Arts learning opportunities which will be added to over time
- Continued review of STEM curriculum and assessment across primary, junior cycle and senior cycle
- Explore the development of a national accreditation framework for whole school culture change at primary and post-primary levels, to address gender balance, equity, diversity and inclusion
- Update and relaunch the STEM School–Business/Industry Partnerships Guidelines and Toolkit which provide the basis for both primary and post-primary schools and business/industry to form quality, inclusive and relevant educational links
- Develop a scheme including the provision of funding to support projects that engage children and young people in STEM in primary and post-primary schools
- Scope out the feasibility, with partners, of developing a Transition Year module/unit at second level on 'Pathways to National Apprenticeships'
- Put in place coherent careers and skills information resources in relation to all learning options for those entering tertiary education, and entering and transitioning within the workforce.

4. Female Participation, Diversity and Inclusion in STEM;

The STEM Education Policy Statement acknowledges that there is a need to increase the uptake of STEM subjects and to enhance STEM learning for learners of all backgrounds, abilities and gender, with a particular focus on uptake by females. In order to drive the actions forward, the Gender Balance in STEM Advisory Group (the Advisory Group) was established with representation from schools, students, parents, initial teacher education, third level, organisations working to improve female participation in STEM, STEM representative organisations and the Department of Education.

While the remit of the Advisory Group was to look at gender balance across all areas of STEM, it was decided that there should be an initial focus on female participation in STEM. In order to establish the baseline, A Review of Literature to Identify a Set of Effective Interventions for Addressing Gender Balance in STEM in Early Years, Primary and Post-Primary Education Settings' was commissioned. This review sets out the key challenges and barriers to gender balance in STEM. It identifies that interventions are required across the STEM education ecosystem to affect change and that there is no single intervention that will achieve gender equity, rather there is a requirement to support multiple interventions addressing different segments of the ecosystem to effect the change required.

Informed by the literature review the Gender Balance in STEM recommendations were published in March 2022. These recommendations look to enable systemic change in addressing the barriers to participation and creating inclusive educational experiences for all learners. The Gender Balance in STEM recommendations have informed actions in the STEM Education Implementation Plan to 2026 which is to be published shortly.

5. **Digital Strategy for Schools**

The Digital Strategy for Schools to 2027 sets out the Department of Education's policy approach on embedding digital technology across the curriculum and in all aspects of teaching, learning and assessment and builds on the achievements of the previous strategy. The stated vision of the Digital Strategy is "to empower schools to harness the opportunities of digital transformation to build digital competence and an effective digital education ecosystem so as to develop competent, critically engaged, active learners while supporting them to reach their potential and participate fully as global citizens in a digital world".

Similar to the STEM Education Policy Statement the Digital Strategy aims to ensure that all learners, regardless of socio economic background, gender or location, are given the same opportunity to develop their digital skills. The Implementation Plan for the strategy is currently being finalised and will make sure to complement and reinforce the STEM Policy Statement to encourage broader participation and enhance STEM learning for all learners.

It is set out under three pillars, each with a different, albeit overlapping, focus. Pillar 1 focuses on the embedding of digital technologies across all aspects of teaching, learning and assessment and the supports and resources that teachers and school leaders need to achieve this. It also addresses what is needed to support learners, including enhancing inclusion, equity and effective participation. At school level, planning for the integration of digital skills is also looked at. All of which is central to the promotion and fostering of digital skills in our learners.

Pillar 2 focuses on technology in the context of infrastructure development in schools including broadband connectivity, technical support and procurement frameworks. It sets out the funding committed to under the National Development Plan (NDP).

Pillar 3 acknowledges the difficulties schools face in unpacking the large number of EU and Government policies and strategies and how system alignment is required to facilitate engagement and successful implementation in related areas such as STEM. In this pillar, the Department commits to helping schools better understand these relationships. It also looks at the important aspect of online safety, new and emerging technologies and the associated issues for the education sector.

The Digital Strategy for Schools is closely aligned with the **EU Digital Education Action Plan (DEAP) "*Resetting education and training for the digital age" 2021-2027*.** The EU DEAP offers a long-term strategic vision for high quality, inclusive and accessible European digital education. It is intended that it will guide and assist policy approaches in the Irish context also.

With regard to funding, the significant investment and direct funding to schools of over €200m under the previous Digital Strategy was seen as fundamental to its success. This new strategy will support the ongoing advancement of digital infrastructure through targeted funding, and working with colleagues across Government to ensure broadband connectivity to all schools, regardless of location. It will be supported through a capital investment of €200m over its lifetime under the National Development Plan 2018-2030. The first tranche of this funding in respect of the 2021-2022 school year, €50m, issued in December 2021.

€50m in grant funding also issued in November 2021, as part of Ireland's National Recovery and Resilience Plan (NRRP), to address the needs of learners at risk of educational disadvantage because of the digital divide. The Department also funds broadband connectivity to all recognised primary, special and post-primary schools through the Schools Broadband Programme at an annual cost of €13m.
The potential for industry to support digital transformation and capacity building in schools, and their willingness to engage on that basis with the Department and with schools, emerged during the consultation process for the development of the Digital Strategy. An Industry Group is being established to harness that input and provide a formal means of communication between the Department and key industry stakeholders to support the implementation of the Strategy and enhance engagement between schools and industry.

Executive Summary

Nurturing children and young people's STEM curiosity starts from early childhood, continues throughout their school learning journey, and beyond into further and higher education and the world of work. Along this journey we must enable learners to become active and reflective participants by providing a range of learning and formative assessment experiences that enhances their curiosity, inquiry, creativity and problem-solving abilities. We must provide a high-quality STEM education experience for all our learners that creates a positive disposition towards STEM and digital learning and enables them to participate, influence and succeed in a changing world.

The importance of a society engaged in STEM and digital learning is set out in the Department of Education's STEM Education Policy Statement and Digital Strategy for Schools. The Policy Statement and Strategy provide a national focus on STEM and digital education in our early learning and care settings, primary and post-primary schools and aim to ensure that all learners regardless of background, gender, ability or location are given the same opportunity to develop their STEM and digital skills.

The STEM Education Policy Statement and the Digital Strategy for Schools are intertwined. They complement and reinforce each other so as to encourage broader participation and enhance STEM and digital learning for all learners. They acknowledge that in order for this to be achieved, school leaders and teachers require the necessary subject matter knowledge, pedagogical content knowledge and the appropriate skills, confidence and competence to embed STEM and digital skills in learning, teaching and assessment in the classroom.

It is further acknowledged that schools must continually evolve, improve and learn from best practice in relation to STEM and digital education in order to ensure sufficient skills within the teaching profession to respond to current and future developments. It is recognised in the STEM Education Policy Statement and the Digital Strategy for Schools that the embedding of STEM and digital skills across the school system requires the provision of necessary professional supports and opportunities for teachers and school leaders such as high quality induction and professional learning, information resources and funding.

It is also recognised that building and sustaining a vibrant STEM and digital education eco-system for all learners will require ongoing innovation in STEM and digital education underpinned by evidence. The continued use of an evidence-led approach will assist in implementing and informing future policy decisions.

The STEM Education Policy Statement and Digital Strategy for Schools focus on the many strengths in STEM and digital education, while providing a roadmap to address the areas for development. They acknowledge that this is a challenge that requires a co-ordinated approach with many stakeholders to work together in order to encourage and inspire more of our children and young people, particularly more females, to engage with STEM and digital during their education and training journeys.

AONTAS Submission to the Joint Committee on Education, Further and Higher Education, Research Innovation and Science, February 2023

Executive summary

1. AONTAS' submission focuses on STEM in Tertiary Education and Diversity and Inclusion in STEM. It:

- outlines some of the key inequalities in relation to 'STEM capital'.
- explores the potential role of non-accredited STEM education in community education settings, and accredited STEM education at levels 1 – 4 of NFQ in adult education, in addressing these inequalities.
- looks briefly at the engagement of learners from underserved communities in STEM-related disciplines in higher education at levels 8 - 10 of NFQ.

It makes a series of recommendations for DE and DFHERIS in relation to the above three points.

2. STEM and STEAM education: AONTAS uses the framework for STEM education developed through NYCI's STEAM in Youth Work project as an existing, evidence-based framework for building STEM capital amongst marginalised communities (of most relevance to non-accredited community education and adult education at levels 1 – 4 of NQF) (NYCI, 2022). This framework defines STEM education:

- as multi-disciplinary including Science, Engineering, Maths AND Art OR Technology
- of relevance to the daily lives of learners (capturing their imaginations)
- as learner-led, hands-on, supporting inquiry-based and experiential learning, and design thinking processes
- as inclusive of all learners and as promoting equity and social justice
- as placing emphasises on the personal and social development of the learner, while also providing opportunities for those with particular interests to develop STEM knowledge, skills and competencies and a range of twenty-first century skills, including digital literacy.

2. NYCI's framework expands STEM education to include Art and become STEAM education because the inclusion of Art diversifies participation in STEM, while deepening the learning experience in STEM and Arts simultaneously.
3. **AONTAS recommends that DE and/or DFHERIS should:**

a. explore the integration of STEM and Art education for the purposes of: broadening participation; deepening the learning experiences in STEM and the Arts simultaneously, and; fostering design, creativity, and innovation (learn from innovative, non-formal educational models such as NYCI's STEAM in Youth Work Framework).

4. **STEM capital:** This submission expands Archer's concept of science capital to STEM capital and uses it to make the case for the delivery of STEM education in community and adult education settings. Science capital comes from a variety of sources, including school, home, out-of-school opportunities and the opportunities people experience in their everyday lives (Archer et al., 2015). STEM capital involves STEM learning, literacy, skills, STEM knowledge and wider funds of knowledge, interest and dispositions, social contacts and networks, and the ability to use and apply these assets/capabilities in daily life for personal and social benefit (Hurley, 2022, p. 9).

5. **Lack of STEM capital amongst marginalised communities:** The Science in Ireland Barometer (2020) reported positive attitudes among the Irish public in general towards science, with three-quarters of people regarding science as useful in solving everyday problems in their lives and 91% agreeing that learning science changes their ideas about how the world works. However, those with lower levels of education are less likely to see a relationship between their real-world experiences and science (Qualia Analytics, 2021, p. 6-7). The Science in Ireland Barometer (2015) presented significant differences in attitudes towards science across socio-economic groups, with:

- 69% of more affluent groups but 50% of less affluent groups expressing interest (Brown, 2015, p.7)
- 98% of the most affluent groups but 88% of the least affluent groups agreeing that 'young people's interest in science, engineering and technology is essential for our future prosperity' (Brown, 2015, p. 20)
- 52% of the general population but 68% of the younger, less affluent population agreeing that 'the way STEM subjects have been taught was off-putting to them' (Brown, 2015, p. 20).

Further, it reports, *"The disenfranchised, representing 19% of the Irish population and consisting largely of the C2DEF socioeconomic segment, are a group who represent a strong possibility for conversion to greater interest in science and technology, they have latent interests which can be further tapped into."* (Brown, 2015, p.7)

6. Recent research by University College London found that there remains significant variation in terms of 'science capital' across gender, ethnic and socio-economic groups. It explored how learners come to see science as 'for me', or 'not for me'. It found that the more science capital a learner has, the more likely they are to take STEM subjects. While it found that most participants aspired to university and professional careers, irrespective of their backgrounds, the formation of science identities are: *"Very heavily influenced by existing social inequalities such as class, gender and ethnicity, and by whether a young person has had opportunities to experience, do well in, feel connected with, be recognised in, and continue with STEM"* (Archer et al., 2020, p. 6). It concludes that unless equity and social justice are placed at the heart of STEM education, the default will be the reproduction of such inequalities and unequal participation in STEM (Archer, et al., 2020, p. 9).
7. We can use the concept of STEM capital as a tool to develop more effective ways of supporting learners to engage with STEM.
8. **The delivery of non-accredited STEM education in community education settings:** Community education presents untapped potential as a mechanism through which the STEM capital of under-represented groups can be built. It is the most inclusive and accessible model of learning across the adult education system (Cobain et al., 2020). Many learners in community education come from marginalised communities that other providers struggle to engage with – e.g., there are much higher proportions of early school leavers, people with disabilities and unemployed people in community education than are in the general population (Bailey et al., 2010). Forty-five percent of community education providers state that members of the Travelling community are part of their learner cohorts (for comparison, in 2021, HEA reported there were only 110 Travellers within the entire student population in higher education (Cobain et al., 2020)). Seventy-seven percent of community education learners are women and more than 50% are over 55 years of age. Over two-thirds of learners live in areas with above average levels of deprivation, with 22% of learners in areas designated as disadvantaged (Doody, 2021).
9. Community education providers are often situated within socio-economically disadvantaged communities. Staff are often local people, many of whom have had similar life experiences to their learners, are trusted, and act as role models. They facilitate a way into the learning setting by removing institutional barriers to access through flexible course provision (accredited and non-accredited), a welcoming environment and, typically, a range of wrap-around services (e.g., childcare and mental health). Non-accredited courses within community education often act as the first step on the pathway of a successful educational journey for learners who have been disadvantaged within the education system and disengaged in the past.
10. Community education is delivered both through independently-managed organisations and as part of the broader statutory Further Education and Training (FET) sector. Nine hundred and eight three organisations were registered with the Irish Charities Regulator for services that include 'the advancement of education' in the voluntary and community sector in 2021. However, AONTAS anticipates the true scale of provision is much greater than this, and will confirm this in 2023 through the creation of an online map of community education provision.
11. Community education's unique and valuable role in engaging marginalised learners is increasingly being recognised within national policy, for example, in the Government's 10-year Adult Literacy, Numeracy and Digital Literacy Strategy (Government of Ireland, 2021) and in the SOLAS FET strategy (SOLAS, 2020). The latter recognises that community education forms a "critical part of provision", delivering "ground-up initiatives developed to serve the needs of particular localities, often in partnership with local organisations". It commits to the development of a Community Education Framework (due for completion in 2023), which will strengthen community education provision across Ireland and enhance progression pathways for the learners, where there is demand.
12. **The potential role of community education in building STEM capital within marginalised communities:** Community education is a powerful tool in the pursuit of educational equality and can play a much greater role in the development of STEM capital amongst marginalised learners, their families, and their communities (particularly in light of the planned development of infrastructure for community education in the SOLAS FET Strategy). Through our knowledge of provision in Ireland, including our extensive network of community education providers, AONTAS is unaware of any delivery of STEM education in community education settings. There is, however, extensive provision of relevant educational programmes,

which could be built into engaging, relevant, hands-on STEM education, such as gardening and recycling, ICT, digital media, visual arts and crafts, and cooking and nutrition.

13. NYCI, with support from Science Foundation Ireland (SFI) since 2017, has developed a nationwide development project, which has led to the proliferation of non-formal, non-accredited STEAM provision within youth work settings across Ireland. NYCI's 'STEAM in Youth Work project' acts as a model of excellent practice which, given the origins, aims and underpinning theoretical frameworks it shares with community education, could be easily transferred to the community education sector to have broader each. In its first five years, STEAM in Youth Work provided engaging, hands-on STEM education opportunities to over 20,000 of Ireland's most disadvantaged young people, including those who are e.g., "early school leavers", "from areas that are affected by generational low educational attainment", "in foster care", "from diverse cultural backgrounds", "have additional needs, including ASD" (Nea, 2022a). Evaluations have evidenced the project's effectiveness in building STEM capital amongst under-represented groups and how the underpinning community education methodologies have provided unique outcomes for learners that are not developed in formal education, for example (Begley, 2021, 2021a, 2022; Hurley, et al., 2022; Whitebarn, 2022):

"STEAM and Digital Youth Work programmes enhance the knowledge, skills and competences of participating youth—including communication skills, meta-cognition, persistence, resilience, collaboration and teamwork, problem-solving, creativity and innovation. STEAM projects in youth work settings offer opportunities for hands-on, experiential learning, which allow for the practical use of tools and manipulation of materials. Many young people increased in self-confidence and motivation for learning as a result of their participation, and reported a sense of pride in their achievements." (Hurley, 2022, p.1)

"The success of the STEAM projects is strongly linked to the caring pedagogies and strategies used by youth workers to support young people and to welcome them into a community of learning where they feel valued, listened to, and ultimately, where they feel a sense of belonging." (Hurley, 2022, p.1)

"The youth work sector can play a key role in providing access to inspiring, youth-centred STEAM engagement which…builds science capital among young people that face disadvantages". (Begley, 2021, p. 65)

"Whatever label is used, and whatever model is adopted, youth work is an ideal setting for transdisciplinary learning. Spaces that nurture belonging are also ideal spaces to nurture play, experimentation and creativity. STEAM should not be promoted within youth work as a means to an end, using arts to make STEM careers more palatable or accessible, or vice versa. It should not be framed as leading to economic advantage, or as a way to inculcate an innovation mindset in the next generation so that they can fix the planetary mess they have inherited. Instead, as demonstrated by the organisations studied for this report, STEAM should be adopted and advanced to support and celebrate youth, to offer them an opportunity for self-discovery and sensemaking, and to give them the agency to shape their own futures." (Hurley, 2022, p. 26)

14. **AONTAS recommends DE and/or DFHERIS should:**

b. develop programmes to resource and develop the capacity of community education providers to deliver non-accredited STEM education to build STEM capital and literacy amongst underserved communities.

c. provide a multi-annual STEAM education fund for statutory and independent community education providers (including small grants because, while excellent, SFI's Discover Programme can be inaccessible to small community organisations).

15. **STEM education for adult learners at levels 1 – 4 of NFQ:** STEM education is currently not provided at levels 1 – 4 NFQ for adult learners. Provision of STEM-related subjects is also limited at this level. For example, a search of QQI's database of accredited programmes reveals there is no science education provision for adults at levels 1 and 2. While there are major awards at levels 3 and 4 in 'Science and Engineering' and 'Science Skills' respectively, they are not provided in more than a third of Ireland's ETBs. Further, the associated curriculum is dated. There is considerable untapped potential here in terms of developing STEM capital amongst segments of the adult population that do not typically engage in STEM.

16. AONTAS is aware of a model of STEAM education for early school leavers that is currently being developed at levels 3 and 4 NFQ by NYCI and the Centre for the Advancement of STEM Teaching and Learning (CASTeL), DCU (Full STEAM

Ahead - A Partnership Approach to STEAM in Youthreach'[1]). This project is based on a pioneering pedagogical framework that was co-designed by learners and staff in three Youthreach centres and CASTeL to respond to the learners' real lives, aspirations, and complex needs. It gives freedom to staff to design STEAM curricula that is responsive to their learners and local contexts whilst ensuring consistency of quality and learning outcomes across the Youthreach sector. Evaluations have evidenced such 'bottom-up' development of curriculum has very successfully engaged learners who would not typically engage in STEM (Begley, 2022; McLoughlin et al., 2022). The current phase of STEAM in Youthreach (2023 – 2024) will see this Framework extended to new Youthreach centres and learners across all of Ireland's 16 ETBs. AONTAS believes there is great potential to broaden participation in STEM by building on NYCI's work to develop STEM education at levels 1 - 4 NFQ and rolling it out through Ireland's 16 ETB Adult Education Services (e.g., Back to Education Initiatives).

17. **AONTAS recommends DE and/or DFHERIS should:**

d. resource a programme to develop and roll out STEM education for adults at levels 1 – 4 NQF.

20. Underrepresentation of learners from certain groups and backgrounds at levels 8 – 10 NFQ in STEM-related education: The under-representation of women in STEM-related disciplines is well documented and recognised in national policy (e.g. DES 2017; DE, 2022). Anecdotal information received through AONTAS' extensive membership/networks suggests that other groups who have historically faced educational inequalities are even more heavily under-represented in STEM at levels 8 – 10 than in higher education generally (e.g. learners with disabilities, learners who face socio-economic disadvantage, Travellers and Roma, home carers, women, learners in direct provision, people experiencing homelessness, learners affected by imprisonment, learners with unmet literacy, numeracy and basic digital literacy needs, and first-time mature students). However, limited data exists about the progression of these groups in STEM higher education to confirm this. There is some recognition of barriers to STEM higher education for groups who face socio-economic disadvantage, for example, with an indicator of success in the government's STEM Education Implementation Plan 2017 – 2019 being that *"The gap in achievement in STEM disciplines between students in DEIS schools and students in all schools is significantly reduced"* (DES, 2017, p. 4). AHEAD has produced data on the representation of students with different disabilities in STEM higher education. In 2014, for example, AHEAD reported that there were approximately 2,700 students with disabilities studying STEM courses. There were 975 students with disabilities in engineering courses – just 6% of all engineering students (AHEAD, 2014). However, there is limited data available online on progression to STEM higher education for other underrepresented groups. Data needs to be strengthened if targeted action to address this likely under-representation is to be taken.

21. AONTAS recommends DE and/or DFHERIS should:

e. implement systems which allow comprehensive national data collection on how learners from groups who have historically faced educational disadvantage progress through levels 8 – 10 NFQ in higher education in STEM-related disciplines.
f. commission qualitative research to look at the experiences of learners from these marginalised groups in STEM-related higher education disciplines and use findings to inform policy and practice on STEM education.
g. expand policy on STEM education to explicitly include all groups who have historically faced educational disadvantage.
h. develop more ambitious and targeted action to address the underrepresentation of learners from socio-economically disadvantaged groups in STEM education at levels 8 – 10 NFQ.
i. expand on best practice emerging from initiatives supported under the National Access Plan and SFI's Discover programme (e.g., STEM Passport for Inclusion[2]) to address under-representation in STEM-related disciplines in higher education specifically.

[1] https://www.youth.ie/programmes/steam-engagement-programme/steam-in-youthreach/#:~:text=Full%20STEAM%20Ahead%20%E2%80%93%20A%20partnership,certification%20in%20supportive%2C%20alternative%20settings.

[2] https://www.maynoothuniversity.ie/all-institute/all-projects/stem-passport-inclusion.

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Capacity for, Access to, and Participation in

Computer Science Education in Ireland

2023/044

Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

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February 2023

Ollscoil na Gaillimhe University of Galway

Lero Software for a better world

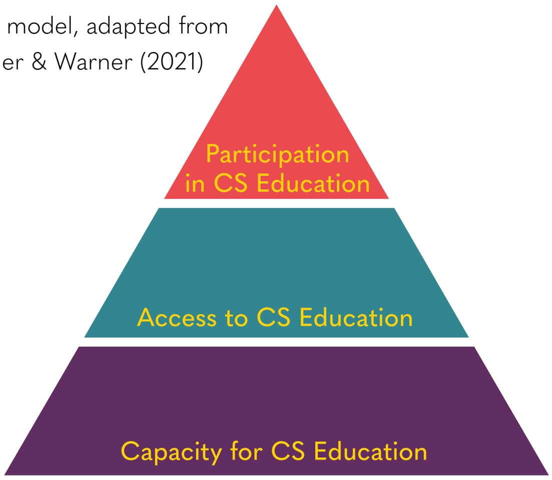
Research supported by Google

Introduction

Ireland is working to become a digital leader at the heart of European and global digital developments. Digital skills and a flourishing Computer Science education ecosystem are essential to this transformation. The recently published [Digital Ireland Framework] sets out a roadmap for the ongoing digital transformation of the economy and the need to strengthen the centrality of education, research and innovation.

However, to grow our digital economy, Ireland needs a digitally advanced workforce ready to take advantage of the opportunities the transformation will bring. This new research led by the School of Education at the University of Galway, ***Capacity for, Access to, and Participation in Computer Science Education in Ireland,*** looks at what is holding back Ireland's digital education, and what can be done to address the challenges.

CAPE model, adapted from Fletcher & Warner (2021)



What is the intersectionality of gender, race, and socio-economic background of CS students?

Do students and teachers have the opportunity to study CS in primary, post-primary and in teacher education?

Evaluate the availability of resources – teachers, policy and schools.

Making digital education a priority

Computer Science (CS) is the study of computer technology, including how coding, programming and computational thinking can be used to solve problems, and how computing technology impacts the world around us. The knowledge, ways of thinking, problem-solving and creativity involved in the diverse field of CS are invaluable skills for the 21st century, and can bring the benefits of innovation and digital transformation to national and global economies alike.

In recent years, the Irish education system has embraced CS as a new curriculum at post-primary by introducing Coding as a Junior Cycle Short Course and CS as a stand-alone Leaving Certificate subject. However, a key finding of this report is that we are a long way off making this important 21st century subject accessible to all students, with just 15.6% of schools offering it at Leaving Certificate level. The research found a low level of understanding of the importance of the subject among both students and teachers, with other areas of the curriculum such as Wellbeing pushing Coding and CS off the timetable.

There is a clear need for developing a consolidated and shared understanding of CS and its relationship with 21st century education. There is a communication and awareness challenge in that all stakeholders – the research community, policy makers, educational authorities and decision makers, school leaders, teachers, teacher unions, families, educational organisations, and enterprises – prioritise and are fully aware of the necessity to champion the development of, access to and participation in CS education.

16%
of post primary schools provide Leaving Certificate CS

1%
of Leaving cert students studied Leaving Certificate CS in 2021

15%
of post primary schools provide Junior Certificate Coding

1%
of Junior Certificate students studied Coding in 2021

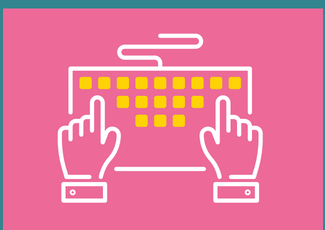
Digital education as a core part of the curriculum

To enhance Ireland's skills and competences for the digital era, opportunities to learn basic digital skills must be provided from an early age. These include computing education, along with comprehensive knowledge and understanding of data-intensive technologies, such as Artificial Intelligence (AI). CS curricula are being introduced in education systems throughout the world, offering young people the opportunity to move away from being passive users of computers to becoming designers and to developing a deep understanding of how technology works.

While young people are often assumed to be 'digital natives' who can pick up computer skills with ease, our research indicates this is not the case. While students have a high level of access to smart technologies, teachers report that their technical use and understanding of computers is much lower, with students struggling to even turn on a computer or use a mouse. To address this, teachers say that digital education needs to be introduced at an earlier age. The research also raises questions in relation to equity of access, with male-female ratio of 78:22 among students who studied CS for Leaving Certificate in 2022.

CS needs to be integrated across all levels in our formal education system. We need to articulate and implement a strategy for the integration of CS through the continuum from primary school to Senior Cycle. We need to make space in the curriculum to include foundational CS concepts in order to develop these key skills, and provide the resources to develop a curriculum that prepares students fully for the digital future.

This research shows:



While young people have good smart technology knowledge, their technical use and understanding of computers is much lower

Only 15.6% of Irish Schools offer Computer Science at Leaving Certificate level

Of this, only 22% of girls studied CS at Leaving Certificate level in 2022

One of the main barriers is the lack of qualified teachers with 34 recorded in August 2022 compared to over 3,000 PE teachers

"When some students come into the class, they're touching the screen, expecting to swipe, and they don't know how to switch on a computer."

(Teacher)

The shortage of teachers with digital and CS skills

Ireland is experiencing a significant shortage of teachers, with Maths, Engineering and other STEM subjects among the hardest vacancies to fill. This research has found that one of the main barriers to expanding CS education in Ireland is a lack of qualified teachers.

An accredited CS teacher must have at least 60 ECTS credits of CS at honours degree level, as well as a recognised teacher education qualification, such as the two-year Professional Masters in Education (PME). Universities offer this as a full-time course, including a school-placement component, which limits students' ability to work during this two-year period, potentially inhibiting the ability of experienced CS graduates to qualify as teachers.

As of August 2022 there were 34 accredited CS teachers registered with the Teaching Council of Ireland. Of the total of 140 teachers currently teaching Leaving Certificate CS, the vast majority of those are doing so without Teaching Council accreditation for the subject. A key finding in this research is that the lack of qualified teachers is a critical barrier to making the Coding Short Course and Leaving Certificate CS available in schools.

To ensure the integration of CS across formal education, computing education thinking must be embedded within all initial teacher education programmes and through continued investment in in-service continuous professional development programmes for teachers.

Accredited Teacher Numbers 2022

	PE	Politics & Society	**Computer Science**
January	3,146	55	**16**
August	3,234	102	**34**

"To get a CS teacher that's actually qualified is very hard ... we have a CS teacher at the minute but he may or may not be here next September."

(Principal)

Recommendations

This research highlights a range of emergent issues and challenges for the effective integration of computing skills and practices within formal education in Ireland across the primary and post-primary sector. In acknowledging and tackling the tightly intertwined issues of gender balance, equity and inclusion, there is a necessity for all students attending primary and post-primary school to have equal opportunity to develop basic CS understanding and skills, including computational thinking and coding. In our analysis and in proposing the four key recommendations below we demonstrate that there is an imperative for change in educational policy required.

1 Consolidated Understanding

We need to develop a shared understanding of CS and strengthen the acceptance of CS as a foundational competence for all, enabling young people to become active participants in a digital economy and society. We need to help school decision-makers to recognise and understand the importance of CS for all students, building systemic knowledge to support good decision-making, and helping them find ways to balance competing academic expectations. Additionally, we need to actively engage parents and students by informing them of the importance of CS education to future success and help them become partners and advocates in making the needed systemic improvements.

2 Support for Policy

Much has been accomplished in Ireland to date with this relatively new academic discipline in schools, but far more needs to be done to ensure that CS education is available and accessible to all students. Broad engagement is needed with key stakeholders across the education system to highlight and optimise the benefits of CS as a key digital competency for all.

3 Systemic Rollout

We need a holistic approach to the introduction of computing competencies in formal education and to create a learning pathway from preschool, through primary and into post-primary school. We need to scale CS education throughout the education system to ensure that all students may participate in this learning regardless of gender, race, school location and socio-economic status.

4 Comprehensive Integration

To ensure this learning pathway across the formal education system, CS, along with digital and computational competencies, must be truly embedded within all initial teacher education programmes and through continued investment in in-service programmes for teachers. Ensuring that new teachers exit from teacher preparation programs prepared to teach appropriate CS content at their respective levels will build greater capacity across the entire education system.

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E.T.T.A
Engineering Technology Teachers' Association
Cumann na Múinteoirí Innealtóireachta Teicneolaíochta
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Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science.

1. The ETTA (Engineering Technology Teachers Association) would like to thank the Committee for the opportunity to make this submission on the topic of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

2. **Introduction**
The ETTA is a voluntary administered association representing teachers of Engineering, Technology and Design and Communication Graphics (D.C.G). Founded in 1983 by Engineering Teachers to collectively promote Engineering in education in Ireland. Through our current membership, we continue to support teachers and students in what is a time of immense change in the Irish education system.
3. Today, the ETTA is regarded as one of the most proactive education groups in the country, with our yearly recognition and awards for Engineering, Technology and DCG students gaining National acclaim. Our role includes the promotion of these subjects amongst students, liaising with statutory bodies, 3rd Level institutions and the provision of resources, training as required for our members.

Overview

4. The future of STEM has become a global priority in the past few years and Ireland is investing heavily in resources to enhance the teaching and learning of these subjects. Despite this, we, in the ETTA, feel that more needs to be done to provide equity of provision and support in various aspects of the STEM areas. Great strides have been made in STEM for the most part, and the work completed is commendable on many levels. Notwithstanding this, our experience and that of our members in the ETTA in one where the 'T' and 'E' are regularly mixed up and lumped in with the 'S' and 'M' for convenience's sake. The many programmes and initiatives already ongoing are squarely aimed at 'S' and 'M' making it difficult to appeal to those active in the other areas. The STEPS Engineers week is a fantastic addition to supporting Technology and Engineering, but its timing is such that is coincides with arguably the busiest time of year in Post Primary classrooms of these subjects, preparation for and submission the Assessment Task in Junior Cycle and Projects for Leaving Certificate. We have seen reduced participation by members in this initiative and find it extremely difficult to garner support for it though our members. We will outline some ideas in the coming sections to attempt to provide some points for discussion for the future.

STEM in Primary Education;

5. As an association for post primary teachers, our expertise lies in the curricula and specifications pertinent at that level. The programmes and initiatives at primary level have a significant impact on how STEM is received in Post Primary. The student experience at primary level is critical in forming the students outlook on STEM subjects, particularly those of Technology and Engineering. The primary curriculum through Mathematics and Social, Environmental, and Scientific Education (SESE) begins the formation of attitudes towards STEM subjects. Our experience would lead us to believe that although curricula are standardised, the modes in which the content is presented to and explored by students can vary broadly throughout the country. This disparity between schools leads to situations in the Technology and Engineering classrooms in 1st Year, when some students are proficient in the use of technology and have experienced varying levels of exposure to design, mechanical principles and coding, to those that have never used a laptop or being given the opportunity to engage with technology on any meaningful level. This gulf in experience in the Science and Maths areas in detrimental enough, but the lack of any kind of exposure to Technology and Engineering has serious implications for our students This gap in knowledge can lead to the situation where students are misguided or misinformed about the subjects that available to them to study in post primary.
6. Curious Minds provided by Science Foundation Ireland has provided great opportunities to primary students to build an interest in STEM from an early age but similar with our experiences of the primary curriculum and its delivery, the equity of engagement with this initiative and others, seems ad hoc at best. We can only surmise that there is a deficit in teacher skill and confidence to deliver such programmes to an appropriate level. These initiatives, while well-meaning and well thought out are not having the desired effect in supporting students transitioning to post primary specifications of study, especially in Technology and Engineering.
7. The transition from primary to post primary has become highly competitive in recent years. Each year post primary schools are announcing enrolment days at increasingly earlier times of the year, to attract the 'best' and least problematic

students to their schools first. This has a detrimental effect on primary students and in turn leads to ill-informed choices of enrolment being made followed by misguided choices of subjects. This rat race is prominent in towns and areas where multiple school types are accessible and there are perceived successes or shortcomings of schools.

8. There is a noticeable lack of awareness and consultation between primary and post primary schools, unless local arrangements are in place in towns around the country. Every effort is made by post primary school to offer places in subjects that are suitable to all students enrolled, and while we do not want to see this diminished, one must also consider the effect of subject choice on developments later in the students' educational journey. Subject choice, while not a precursor for career choice, can determine the direction a student may want to explore in their life. Consequently, a student's experience and attitude to STEM subjects at such a critical time in their education of study will affect subject choice and naturally the numbers in certain STEM subjects in post primary school. This of course leads to uptake and provision for STEM based courses in tertiary education which we will look at later in this document.
9. There are many facets to addressing this, some of which are already being undertaken. The downside to current CPD is that it's on an ad hoc basis for teachers, meaning without a teacher being interested in a particular area, they may not necessarily engage with it. We feel there is a need for an educational campaign with supporting CPD for primary teachers to provide in-depth and meaningful experience and resources to aid all the primary teachers of all aspects of STEM subjects, with specific emphasis on supporting the transition to post primary. It would be important to engage parents through a national information campaign on STEM subjects and the progression from primary to post primary and tertiary, while informing them of careers available and paths after the completion of tertiary education. The STEM area is ever changing and generally, without specific knowledge about an area of STEM, parents fall into using outdated, stereotypical outlooks on these areas, undoubtedly influencing their kids.

STEM in Post-Primary Education;

10. The recent changes in Junior Cycle, specifically the specification update and name changes for Engineering, Applied Technology and Graphics have been instrumental in giving those subjects a new lease of life in Post Primary schools. The ETTA engaged with the NCCA and all stakeholders proactively during specification review and consultative periods to develop specifications which would broaden the reach of the subject while also retaining key elements that teachers and students enjoyed and excelled at. We felt that a strong weighing on practical project work was essential to broaden the base of skills, which would support students in future studies in these subjects and others. The Junior Cycle as a programme aims to embed these principles which have always been core elements of our subjects.
11. The *STEM Education Policy Statement 2022-2026* outlines data up to 2018 showing the uptake of the STEM subjects. Maths and Science taken separately to Applied Sciences (incl. Agricultural Science, Technology, Construction, Design Communication and Graphics, Materials Technology, Technical Graphics, Metal Work). While trends are changing, the historical context of the education system needs to be considered. Maths is a core subject studied by all students. Science, although not core, was considered by most schools as a subject that all students would sit at Junior Cert level. This is still the case in most schools although not official DES policy.

Junior Cycle 2022
Total Candidates: 67,130
Total Science Candidates: 62,554 *(SEC 2022 Statistics)*

12. The Applied Sciences subjects have maintained numbers for the most part with some fluctuations in the data considered in the report. In analysing the latest published data from the SEC, the numbers in the Junior Cycle subjects of Engineering, Applied Technology and Graphics have increased dramatically since the implementation of the new specifications and more importantly in our opinion, the updated subject names.

Year	Metalwork- Engineering	Technology - Applied Technology	Technical Graphics - Graphics
2019	Total: 6438 Male: 5732 (89.0%) Female: 706 (11.0%)	Total: 3913 Male: 3073 (78.5%) Female: 840 (21.5%)	Total: 9816 Male: 7811 (79.5%) Female: 2005 (20.5%)
2022	Total: 9050 (+28.8%) Male: 7712 (85.2%) Female: 1338 (14.8%)	Total: 5662 (+30.8%) Male: 4415 (77.9%) Female: 1247 (22.1%)	Total: 13883 (+29.2%) Male: 10790 (77.7%) Female: 3093 (22.7%)

(SEC 2019 & 2022 Statistics)

13. The increase in uptake in Technology and Engineering is very encouraging and we would like to commend all stakeholders for their part in making the improvements happen to allow this. The DES Building unit has made regular updates to Room Equipment Lists which has seen the sourcing and purchase of new technologies possible for schools. There are more improvements that can be made, and we will continue to work with them to fine tune this to provide equality of access to all the latest machinery and processes. We commend the SEC for their part in making the examination process more

relevant and accessible to the students of our subjects. We receive regular positive feedback in relation to this from our members.

14. Pushing on to the next level for Technology and Engineering will require continued and increased financial support to schools to enhance the access and experience of students within the subjects. The new focus in our specifications is allowing a wide scope of interpretation in Technology and Engineering which has been very well received, but these changes in direction require ever varying consumables and materials to be purchased. Inflation has affected these subjects substantially, with materials and maintenance costs increasing significantly in the past few years. This is a worry for teachers of our subjects as schools are becoming ever more stretched in their budgets.
15. Post primary school, like any educational institution is constrained by resources, specifically allocation and timetabling. Timetabling is one of the single biggest issues surrounding the provisioning for Technology and Engineering and the uptake of the subject. It also affects the gender balance within the subject. Historically, the vocational subjects were male dominated and regularly were timetabled against subjects which were female dominated, take Home Economics as an example. The stigma attached to STEM subjects needs to address more vigorously and concerted national effort to change this needs to be undertaken. Unfortunately, this view on Technology and Engineering continues in many schools, and these subjects continue to be offered up against the subjects that allow for this trend to persist. This is address locally in schools, but the reality is that this historical norm is embedded in school culture and is very difficult to change. Compounded by the issues outlined in the transition from primary to post primary, one can understand the difficulty that lies here. The new Junior Cycle programme lends itself to providing subject taster programs which can help to alleviate the extremes of this phenomenon, but these can lead to undesirable outcomes in time allocation for subjects.
16. Many excellent Technology and Engineering initiatives take place in schools which do wonders to increase the profile and reach of the subjects. Resourcing and time are two major factors which either allow these to flourish or doom them to fail within schools. A framework for a standardised programme of extra-curricular Technology and Engineering initiatives would be a great way of providing equity of access for students, particularly those in DEIS schools and from disadvantaged areas.
17. Technology and Engineering teacher training education has gone through its biggest change in 40 years, which will only serve to improve the quality of teachers entering the profession. Alongside this improvement, the assessment of the skillset needed for teaching STEM subjects needs to be reviewed to promote an emphasis on technical abilities as well as pedagogical competencies. The Teaching Council, with the 3rd level institutions should address this and address the disparity in accreditation given to teachers in Technology and Engineering.
18. We welcome the move to encourage more co-ed schools as it provides a unique opportunity to financially support schools in the promotion and access to STEM subjects, particularly Engineering. A move to investing in Engineering rooms and facilities provides the opportunity and access to teach Technology, but the opposite is not true. This should be the default position when investing in new schools or upgrading existing buildings.

STEM in Tertiary Education;

19. We are delighted at the move to Technological Universities and the investment being provided to further expand their reach and influence. The continued investment in Apprenticeship programmes and Post Leaving Cert courses also provide a wide range of opportunities for students that do not want to follow the traditional route to QQI Level 8 qualifications. Further work is needed in cementing the links between post primary and tertiary education like that previously outlined in part 1. These links could be strengthened by working with post primary schools and bodies to support the content being covered and skill set being nurtured to ease the transition to tertiary education. The pathways right through a student's education should be easily identifiable to lay out a clearly defined career path. This would in turn reduce the chance of students undertaking a programme of study and then leaving it, affecting their grants and time in education. This is particularly problematic in courses at TU's. Aligned with educational campaigns at primary level to support parents and students through subject choices, a campaign to support post primary career guidance facilitators and teachers in advising students on the best path to take should reduce the possibilities of students misaligning their aspirations for their future.

Female Participation, Diversity, and Inclusion in STEM;

20. It is regrettable that female participation in STEM maintains its status as a topic of diversity and inclusion. To consider the future of STEM education in Ireland, it is meaningful to review the current policy statement on STEM, 'STEM Education, Policy Statement 2017-2026', with a concentrated focus on female engagement in Engineering and Technology subjects.
21. A convenient manner in which the number of students completing our subjects can be assessed, is through the statistics published by the State Examinations Commission. Whilst the number of students completing the Examinations fluctuates annually, we can see a general increase in numbers across the two subjects of Engineering and Technology. Notable is the persistent increase of students completing Leaving Certificate Established (LCE) Technology since its introduction in 2007 and first State assessment in 2009[1]. Between the years 2009 to 2017, LCE Technology grew by 52.4% amongst female and 58.7% amongst male students from, 129 to 217 and from 406 to 2920 female and male students respectively [2,3]. LCE Engineering saw a less significant growth of 18.1% female, 258 to 315 and 6.2% male, 4651 to 4960 students during the same years.

22. Whilst we take great pride in seeing the number of females opting to study Engineering and Technology subjects increasing annually, we recognise the multitude of factors influencing this increase, whilst simultaneously being conscious of what could be done to further boost the female involvement. The before mentioned newly published Junior Cycle specifications, and the name changes, have had a positive impact on female engagement. Additionally, we are seeing more and more schools introducing an 'E' or a 'T' subject into their schools.
23. It is important to recognise that there is still a considerable number of single-sex female schools which do not offer any of these subjects to their students. Schools that do make the advancements to expand their curriculum to include one of such subjects, often opt for Applied Technology or Graphics, which long term can work to only perpetuate the idea of Engineering being a male subject.
24. Previous research has shown the negative attitudes and comments females wishing to study Engineering experience whilst in a co-educational school. Such attitudes arising not only from their peers, but also their teachers [4]. We are also conscious of timetabling decisions which continue to place Technology and Engineering against those previously classified as 'female' subjects [5]. We would like to be hopeful that such research has become outdated, however we must accept that such mindsets still exist amongst our students, colleagues and schools, otherwise we would no longer be classifying female participation in STEM as a topic of diversity.
25. There is much that can be done to further increase female involvement in STEM. The current 'STEM Education, Policy Statement 2017-2016' outlining the aims that "uptake of STEM subjects by females to increase by 40%"[1] seems perplexing when considering our current situation. Junior Cycle Engineering has already accomplished this target, with the number of female students increasing by 41.4% in the years 2017 to 2022, from 784 to 1338 [3,6]. Which can be deemed as impressive, until it is compared to the 7712 male students that completed Junior Cycle Engineering in 2022[6].
26. Therefore, to increase the number of females engaging in STEM education, a collected approach is required. As outlined a previously, the primary years are crucial in establishing student interest, engagement and understanding of STEM. This would also assist in combating the lower self-efficacy levels found across female students in tertiary STEM education[7]. National STEM policies and initiatives should be reviewed and implemented to combat the inequalities in STEM education. Such policies should establish more impactful targets and clearer guidelines of how they aim to be achieved.

Digital Strategy in Education to Support STEM;

27. The Digital Strategy for Schools has been a wonderful source of direction for schools in the past few years. Formal digital strategy teams, team leaders and plans have allowed schools to develop teachers' skillsets, provide opportunities for students and reimagine classrooms and their use of technology. As with any initiative there have been many good points and some negatives. From the STEM point of view, and specifically Technology and Engineering, the Digital Strategy for schools reinforced much good practice and pedagogies that were already evident and second nature to some teachers of these subjects. Unfortunately, like many initiatives, on the ground, the reality of the plans centred around one question. "How much funding was being given?". The subjects of Technology and Engineering have always been avid supporters of the use of modern technologies, from Computer Aided Design to Computer Aided Manufacture, to Computer Numerically Controlled machines and micro controllers. The initiation of the Digital Strategy coincided with reimagining of the Junior Cycle and this in turn meant an update of specifications and equipment. The reality meant that the budget for Digital Strategy was a catch-all method to fund the changes needed in subjects and investment was at a premium considering the overall needs of schools. This was even more pronounced in DEIS schools, where despite the extra funding they receive from different initiatives, the socio-economic situations of their student cohort often meant that the Digital Strategy funding was a drop in the ocean in providing for the needs of the school. This combined with the attitude of use the Digital Strategy funding for upgrading STEM subjects in the areas of 3D Printing and Laser Cutting capabilities meant the funding was sparce in certain circumstances. Thankfully, this has now changed, but the funding deficit for devices for students remains.
28. As building plans are continually improved, one would hope that facilities and access to them would also get better. On the contrary, the new room designs for Technology and Engineering sees the removal of dedicated devices from the room. This makes little or no sense in a time where students need more access, not less, to program devices, produce digital folios and undertake digital design. A decision like this would seem to us to be somewhat short-sighted in the grand scheme of Digital Strategy. Equity between schools in relation to facilities is a key factor in increased educational outcomes. It is imperative that the investment is continued and sustained based on the provision of access to new technologies and renewal and replacement of outdated equipment.

Conclusion

29. Improvements around STEM education are ongoing and incremental and require the nuanced approach of multiple agencies, government departments and partners. While being so complex, a single pronged approach to improvements is not the answer even a jurisdiction as small as ours. SFI has been instrumental in its work throughout the area in all levels of education in Ireland and without them we would be in a place much worse off. Ireland is uniquely placed in the world with the top tech companies and business on our doorstep to support the different sectors in education. This partnership is flourishing in some areas of the country in some sectors. Localised initiatives and supports are of huge benefit for schools and colleges in improving outcomes and access to STEM careers for students. This is evident long

before formal initiatives were put in place to address shortcomings we might have had. The current environment and level of access to technology in general should allow this model to continue to improve at a rate which is quicker and more effective than past ventures. Key to all this success is our education partners and stakeholders and teachers have a unique role in this regard.

30. As mentioned, we in the ETTA are a voluntary organisation with a modest membership in comparison to other subject associations, but with a wide reach to those teachers involved in our subjects. We have been instrumental in outlining a vision for our subjects currently being offered in post primary. Like our sister associations the Maths and Science areas, we do not have the resources or personnel needed to affect significant change on a national level, while engaging as teachers in our paid job roles. Building partnerships and fostering effective programmes of learning for our members and our students takes significant time, and in modern schools with teaching and leaderships roles, time is a commodity we are seriously lacking in.
31. Effective change in the areas of STEM mentioned requires a multi-pronged, muti-faceted approach that places teachers at the centre of it. Technology and Engineering are the two areas of STEM we feel have been left between the two stools of Science and Maths. We fought hard in our discussions and consultation through the review of Junior Cycle to maintain the unique characteristics of both subject areas so that students and teachers could continue to experience the key areas distinctive to both areas. Reading the literature and researching the topic of STEM has only reinforced our view that Technology, even as a subject rooted in both JC and LC, seems to be a catch all term to cover digital aspects, ICT, devices rather than recognising the core subject elements of Manufacturing Systems, Electronics and Control, Applied Control systems and so on. Supporting this view, Engineering is addressed in similar way at times, neglecting the key areas of Manufacturing Technology, Metrology, Machining, Polymers and Design.
32. We are in a position with a unique opportunity to build on the great work already being done and to make significant strides forward in the areas of Technology and Engineering in STEM. This needs to happen in partnership with all stakeholders to be as effective as it can be. We in the ETTA look forward to being a key aret of that process.

Barry Convey
National Chairperson
Engineering Technology Teachers Association

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[4] 'Man Enough to do it?' Girls and non-traditional subjects in lower secondary education; https://doi.org/10.1080/09540250802415124
[5] Gender and Subject Choice: Take-up of Technological Subjects in Second-Level Education; https://www.esri.ie/publications/gender-and-subject-choice-take-up-of-technological-subjects-in-second-level-education
[6] Junior Cycle 2022 Provisional Gender Statistics Common Level (with 10 or more candidates) https://www.examinations.ie/statistics/
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Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science on the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

National Adult Literacy Agency
Áisíneacht Náisiúnta Litearthachta do Aosaigh

2023/046(i)

27 February 2023

1. Introduction

We are the National Adult Literacy Agency (NALA), a registered charity with 2,300 members. We believe literacy is a human right. We are committed to making sure people with unmet literacy, numeracy and digital literacy needs can fully take part in society, and have access to quality learning opportunities that meet their needs.

NALA welcomes the opportunity to contribute to the consultation on the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

2. Literacy, language, numeracy and digital literacy skills

These skills involve listening, speaking, reading, writing, using numbers and everyday technology to communicate, to build relationships, to understand information and make informed choices.

Literacy, numeracy and digital literacy skills enable people to reach their full potential, be active and critical participants in society and help address poverty and social exclusion. These life skills allow us to participate in, and make sense of, the world.

3. Literacy, language, numeracy and digital literacy needs in Ireland

Unmet literacy, language, numeracy and digital literacy needs arise because of educational and wider structural inequalities.

The most recent adult literacy survey[1] showed that:

- One in six (18%) adults (aged 16 to 65) struggle with reading and understanding everyday text. For example, reading a bus timetable or understanding medicine instructions.
- One in four adults (25%) has difficulties using maths in everyday life. For example, basic addition, working out a bill or calculating percentages.
- About 2 in 5 (42%) adults struggle with basic digital tasks. For example, they find looking up a website or sending an email difficult. Note that the majority of people who have digital literacy needs have underlying literacy issues.
- There are also language needs amongst many adults where English is a Second or Other Language (ESOL).

The literacy, language, numeracy and digital literacy skills that we use and need:

- are not static and evolve constantly.
- are not something that you get once in school and you have it forever – you must practise these skills or you lose them – deskilling.
- can vary depending on the context, for example, dealing with a lawyer and legal terminology or studying a course and language specific to it.
- Can differ from one skill area to another – for example, a person can be good at reading, but struggle with writing – people have "spiky" profiles.

4. Addressing adult literacy, numeracy and digital literacy needs

The Government recently published a [10-year Adult Literacy for Life Strategy], which aims to

> "ensure that everyone has the necessary literacy, numeracy and digital literacy to fully participate in society and realise their potential".

It is vital that STEM programmes are available to everybody, including people who have unmet literacy, numeracy and digital literacy needs. To achieve this, it is necessary for literacy development to be integrated into STEM courses. This ensures people wishing to undertake STEM programmes are not excluded because of the literacy and numeracy demands of the course.

[1] CSO (2013). PIAAC 2012 Programme for the International Assessment of Adult Competencies: Survey Results for Ireland

Integrating literacy

Integrating literacy means designing and delivering courses in ways that remove unnecessary literacy barriers and that develop the key course-related language, literacy and numeracy.[2] Research shows that integrating literacy into further education and vocational training leads to higher participation and retention rates; increased achievement of qualifications and increased achievement of other course goals.

In the past, the most common approach to integrating literacy and numeracy was to deliver standalone classes alongside the programme (the discrete model). This was based on the perception that those undertaking courses at National Framework for Qualifications (NFQ) Level 5 and above possessed the necessary literacy, numeracy and digital literacy skills.

In recent years, there has been an acknowledgement that many learners at these levels can also struggle with literacy and numeracy, including apprentices.[3] As a result, ETBs now provide literacy support as an integrated part of the training programmes at all levels. This encourages learner participation as they recognise it is relevant for their FET area. It also ensures that literacy and numeracy provision is framed around supporting learners to achieve their FET programme.

5. Adult literacy and Science, Technology, Engineering and Maths (STEM)

Science, Technology, Engineering and Maths (STEM) are important skills for every person in today and tomorrow's world. Developments in science and technology in particular are changing fast and we are dealing with a climate crisis. We all need to be think critically to make informed choices and decisions. The benefits of having adults and grandparents learning about STEM means they are not only better informed but also model curiosity in these areas for the younger generation and inspire them to keep learning about STEM.

Adults learn best when they are interested in the topic and when new information is made relevant to their current experiences and interests. STEM is well-suited to adult learning as hands-on experimenting allow you to make scientific ideas practical in everyday life. However, STEM education is currently not provided at NQF Levels 1 – 4 of for adult learners. There are limited STEM-related subjects also at these levels.

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[2] NALA (2013). Integrating Literacy: Guidelines for further education and training centres.

[3] SOLAS (2018). Integrating Literacy and Numeracy Research Report

6. Recommendations on the future of STEM in Adult Literacy and Community and Adult Education

1. Develop and deliver STEM courses at NFQ Levels 1 to 4

We need to invest in developing and delivering STEM courses at these levels.

When designing new courses, the **process** should:

- Engage with adult learners to see what STEM topics they are interested in learning about. This could include family STEM courses where both parents / caregivers and children / young people learn together; work related STEM courses.
- Include learners in the development, piloting and evaluation processes.
- Use plain language and universal design principles.
- Consider the National Youth Council of Ireland (NYCI) STEAM in Youth Work project as an existing framework. It defines STEM education as:

  - multi-disciplinary including Science, Engineering, Maths and Art or Technology
  - being relevant to the daily lives of learners and captures their imaginations
  - being learner-led, hands-on, supports inquiry-based and experiential learning, and design thinking processes
  - inclusive of all learners, promoting equity and social justice
  - emphasising the personal and social development of the learner while also providing opportunities for those with particular interests to develop STEM knowledge, skills and competencies and a range of twenty-first century skills, including digital literacy.

The new courses should be part of the learning offering in adult literacy services and community and adult education. They can be **delivered using the integrating literacy approach** where adults can be given course-related literacy, language, numeracy and digital literacy support while doing the course.

When the STEM courses are developed, **adult literacy and community education providers must be adequately resourced and supported** to deliver these new courses. There is also a need to resource providers to develop non-accredited STEM education in adult literacy and community education settings for the purpose of building science and STEM capital amongst marginalised cohorts who are under-represented in STEM-related further and higher education and careers.

2. Integrating literacy, numeracy and digital literacy into STEM courses at NQF Levels 4, 5 and 6

In the SOLAS Report (2018), there were identified actions under six areas. Five years later, it is time for a **review of these actions on integrating literacy** to identify progress and gaps. A part of the review could specifically look at STEM courses at Levels 4, 5 and 6 and how integrating literacy is working. The review would identify **further actions** for the coming years.

3. Female Participation, Diversity and Inclusion in STEM

In Ireland, out of almost 120,000 people working in STEM, just one-quarter are women.[4] Women and other groups (such as ethnic and socio economic) are also under-represented in studying STEM as well as in the workplace. The report noted that "to make a STEM career appealing, all learners, and especially females, need to be made aware of the exciting opportunities available and be able to see people like them working in these areas."[5]

Developing and delivering STEM courses at NFQ Levels 1 to 4 (as mentioned above) would provide **opportunities for under-represented groups** to participate in courses and in a literacy friendly way. Where adults have unmet literacy, language numeracy and digital literacy needs, courses can integrate literacy into them.

4. Digital Strategy to support STEM

Adults need basic digital skills to participate fully in lifelong learning and further education and training. Ireland needs to agree and adopt a lifelong / life wide **digital skills curriculum** (linked to the Digital Competence Framework for Citizen DigiComp 2.2) and integrate digital literacy skills into all STEM courses.

Follow on and contact information

NALA is happy to talk further about these recommendations.

Contact person:

Helen Ryan, NALA Policy Officer

Tel: 01 412 7900

Email: hryan@nala.ie

[4] Department of Education (2022). Recommendations on Gender Balance in STEM Education

[5] Ibid

Future of Science, Technology, Engineering and Mathematics (STEM) in Irish Education

IRISH FEDERATION OF UNIVERSITY TEACHERS (IFUT)

1. Position Paper

1.1. Science, technology, engineering and mathematics (STEM) education and research are increasingly recognised globally as fundamental to national development and productivity, economic competitiveness and societal wellbeing.

1.2. The unprecedented economic, pedagogical, cultural and social impact of the Covid-19 pandemic on higher education has led to transformations in education and academic practice in Higher Education Institutions which are yet to be fully realised.

1.3. There can be little doubt that these interacting factors will have a significant impact on higher education in Ireland and on the working conditions of academics, in the short and long term. At the same time, drivers such as increasing student numbers, widening participation and resource constraints and decreased funding have contributed to higher teaching, research and administrative loads amongst many academics (Kenny, A. 2015; Kenny, J. 2017; Watson et al., 2015). Academics are also under increasing pressure to publish high quality research; to apply for grants, to demonstrate research impact and to build external links with industry and community (Collins, Crowley and 2020). STEM fields in particular are developing at a rapid pace, boosted by technological advances such as 'big data'[1] and new possibilities for automation.

1.4. IFUT welcomes thoughtful discussion exploring ideas for the future of Science, Technology, Engineering and Mathematics [STEM] in Irish education and on the future of STEM in higher education in particular.

[1] Big data refers to data that is so large, fast or complex that it's difficult or impossible to process using traditional methods.

2. The Precarity of academic careers must be addressed

2.1. Ireland's skills gap is long-running and IFUT believes there is a mismatch between the scale of the problem and the solutions offered to date. While IFUT welcomes initiatives such as the publication of the Department of Education national STEM Education Policy Statement 2017-2026 (Policy Statement) and STEM Education Implementation Plan 2017-2019 in November 2019 it is difficult to see how the stated vision and '…*ambition to have the best education and training service in Europe by 2026, [where] Ireland will be internationally recognised as providing 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 learning*." – can be realised when the levels of precarity experienced by researchers and academics in higher education remains consistently and unacceptably high.

2.2. Although widely recognised by many, particularly in industry, in government policy documents and in academic research for some time as a significant problem, the precarity of academic careers continues and is increasingly exacerbating Ireland's growing skills gap in STEM. Substantial numbers of STEM researchers and lecturers work in precarious employment beyond the traditional 'early career' phase.

2.3. The Strategy for Science, Technology and Innovation 2006-2013 recognised the need to develop "attractive career paths for post-docs". The Interdepartmental Committee on Science, Technology and Innovation (2015) required the Higher Education Authority and Science Foundation Ireland "*to establish improved system-wide tracking of researcher mobility into industry*" by 2017. No attempt has been made to do this. [*Irish Times 27th May 2022*].

2.4. IFUT believes resilience of STEM academics in education-focussed roles will be critical if educational reforms are to be successful. In universities across the globe, researchers – experienced and early career alike – persevere in the academic 'gig' economy hoping it will lead to something better. That hope often falls foul of reality for academics working on contract. Ireland has an opportunity to become a leader in institutional change.

2.5. In this regard IFUT has welcomed the Oireachtas Committee Report '*The Future Funding of Higher Education*' which includes an examination of the needs of those in precarious employment and atypical contracts in higher education. The Report states it is "…*imperative that Irish Universities ensure their research staff have employment contracts that offer security of tenure, career progression pathways and salary scales that are commensurate with their qualifications and experience*."

2.6. It is imperative there is sufficient funding of STEM education in higher education to enable a sustainable higher education system and ensure students and staff alike are enabled to achieve maximum educational outcomes, while ensuring that higher education remains able to deliver the highest standards of research and teaching in STEM subjects and continue to support Ireland's social and economic development.

2.7. The fixed-term nature of many academic contracts contributes to the precariousness of academic careers – continuing to employ people on a succession of short-term contracts is not acceptable.

3. Equity and Inclusion
Addressing gender stereotyping in STEM: Women in the Academy

3.1. IFUT recognises the status of women in STEM in higher education has made strides toward gender equality, but it still has some way to go. Although coming from a very low base, support from higher education and government has led to strengthened efforts to recruit women academics and researchers in STEM.

3.2. However, the literature on "gender and science" underlines how much careers in science and academia are still subject to discrimination according to the sex. This becomes visible in the famous scissor-shaped curve (see the SHE-figures report 2013 for Europe), where one can observe a progressive "evaporation" or disappearance of women as they advance in the career; an occurrence, which is called the "leaky pipeline" phenomenon (Berryman, 1983; Alper, 1993).

3.3. In Ireland women continue to be underrepresented in science, technology, engineering, and mathematics (STEM) fields and in STEM leadership positions. 41 per cent of those graduating with a PhD in science, mathematics and computing are women — lower than in the EU, but nevertheless within a 60/40 definition of gender balance. However, that "…*disappears when we look at those who are permanent Stem academics (only 35 per cent of whom are women, compared with roughly half in the EU). The picture becomes even more unbalanced at full professorial leve*l" [*Irish Times2 7th May 2022].*

3.4. According to the most recent data available from the National Science Foundation, in academia only 31% of full-time STEM faculty and 27% of STEM Deans and Department Heads are women [*National Forum on Teaching and Learning*].

3.5. Occupational segregation and affiliated stereotypes are strong influences on career development. Stereotypes about people who are interested in STEM abound in popular culture, making it one of the largest barriers to women [Blackburn 2017]. Women scientists are still seen as the exception.

3.6. The representation of women and minorities in STEM matters. Diversity in the workplace contributes to creativity, productivity, innovation and success. "Women's experience – along with men's experiences – should inform and guide the direction of engineering and technical innovation [Corbett and Hill 2015: 92).

3.7. Reducing the gender gap in Science, Technology, Engineering and Mathematics education areas will help reduce skills gap, increase employment and productivity of women and reduce occupational segregation.

3.8. IFUT calls for fundamental, long-term, coordinated transformational change of the entire system to prepare Ireland for the future.

2023/048

Written submission to Joint Committee on Education, Further and Higher Education, Research, Innovation and Science, as part of the Committee's examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

Professor Hamsa Venkat & Dr Margaret Leahy

School of STEM Education, Innovation & Global Studies/Centre for the Advancement of STEM, Technology & Learning (CASTel)

Institute of Education

Dublin City University

27 February 2023

Chairperson and Members of the Committee,

My colleagues and I are pleased to assist this Committee in its consideration of topics referred to in your letter of January 23rd. The submission was prepared by Professor Hamsa Venkat (Naughton Family Chair in Early Years/Primary STEM Education) and Dr Margaret Leahy (Head of School of STEM Education, Innovation & Global Studies) with contributions from colleagues[1] in the school and across the Institute of Education and CASTel in Dublin City University.

1. Introduction

In recent years, STEM education has become a high priority for governments and educational policy-makers around the world. Countries with dynamic economies tend to have effective education systems that prioritise STEM education and recognise STEM literacy as empowering for citizens. The STEM Education Policy Statement (DES, 2017)[2] and Implementation Plan (DES, 2017)[3] are aimed at making Ireland a leader in STEM education by 2026. A key focus in the implementation plan is *on reviewing, with a view to enhancing, the supports in place to ensure our teachers feel confident to embrace STEM (p.11)*. This is of vital importance if we are to address this challenge

2. What is STEM Education?

Understandings of what STEM is vary greatly and this lack of consensus presents challenges for both educators and policymakers. Descriptions vary from the simple mention of one discipline when dealing with another (e.g. making connections with mathematics when teaching science); to more extensive transdisciplinary immersion in understanding and solving real-world problems in which students are required to draw on concepts, skills and ways of knowing across several STEM and other disciplines. With particular reference to the future of Science, Technology, Engineering and Maths (STEM) in Irish Education, our view is that STEM incorporates disciplinary knowledge, values, skills and processes in Science, Technology, Engineering and Mathematics while also promoting an applied, problem-solving orientation learning across and between these disciplines i.e. integrated STEM.

The evidence base points to integration of STEM disciplines as promoting the development of transversal competences including: problem-solving, innovation & creativity, communication, critical thinking, metacognitive skills, collaboration, self-regulation, while also contributing to the development of disciplinary competences. Disciplinary competences refer to the knowledge, skills and attitudes that are required by a specific STEM discipline. Transversal skills are recognised as '21st century' or life skills required to successfully navigate an uncertain, rapidly changing world and feature prominently alongside disciplinary competences in Aistear: the Early Childhood Curriculum Framework (NCCA, 2017)[4], the new Draft Primary Curriculum Framework in Ireland[5] (NCCA, 2022) and the Frameworks for Junior Cycle (NCCA, 2015)[6] and Senior Cycle[7] (NCCA, 2017) at Post Primary level.

The empirical base, while still relatively small, demonstrates that providing students with an integrated STEM education develops students' awareness of crosscutting concepts and real-world applications in a holistic manner and strengthens the transfer of knowledge acquired to different contexts.[8] However, a key and critical caveat is that STEM education provision in disciplinary and integrated forms is premised on teachers having the necessary content knowledge and confidence across the STEM disciplines and the ability to integrate the STEM disciplines in order to provide meaningful learning opportunities for their students. Several studies note that this condition is poorly met at pre-primary and primary levels[9] and that at primary and post-primary levels, the emphasis on traditional subject areas makes integrated STEM more difficult. Across primary and post-primary levels, the evidence points to the need for clear communication of the rationales and motivations for integrated STEM education, and a longitudinal approach to pre- and in-service teacher professional development that includes the provision of curriculum and teaching materials and resources to support STEM teaching and learning.

3. Female Participation, Diversity and Inclusion in STEM

Gender inequity issues in relation to STEM exist in terms of the low numbers of females opting to continue STEM studies to Leaving Certificate level, and the percentage exiting as higher education STEM graduates[10]. Studies repeatedly show early (approximately the age of five or six) writing off of some career options amongst children, that girls start losing interest between 13 to 15 years old and the gender gap becomes progressively more pronounced through later post primary schooling and third level (DES, 2016; SFI, 2015). Factors that influence these decisions include the perceived gender-appropriateness/stereotyping of careers, lack of knowledge, and lack of role models.[11] [12]

To increase diversity in STEM, there is a need for equity of access to high-quality STEM education in schools at all educational levels from early childhood onwards. It is critical that all students have access to the widest range of STEM subjects in schools and to teachers who are appropriately qualified to teach these subjects.[13] Teachers have great potential to foster students' STEM interest and identities through innovative classroom practices, as well as providing access to role models and information about the diverse careers that exist within STEM industries.

4. **Digital Strategy in Education to Support STEM**

The Digital Strategy for Schools[14] published by the Department of Education earlier this year aims to work alongside and reinforce the Department's STEM Education Policy Statement 2017-2026 to encourage broader participation and enhance STEM learning for all learners, with a particular focus on increasing participation in STEM by females. The forthcoming Implementation Plan of the Strategy is critical to reinforce and complement existing and future actions in STEM Education.

5. STEM Education in Early Childhood Education and Care (ECEC)

It is well recognised that important foundations for future learning, achievement and wellbeing are developed in the early years. This is similarly the case for STEM Education. Young children are naturally inquisitive, creative, and collaborative; these are innate dispositions which lend themselves well to STEM education.[15]Although an emergent area of focus in ECEC, STEM research and policy published in the last five years recommends the introduction of STEM education at an early age[16 1718]. This is perceived as important for the development of the foundations of skills, knowledge, beliefs, confidence and self-efficacy in STEM.[19 20 21 22 23] It is also important as STEM achievement gaps are known to begin in the early years and will persist if unaddressed.

The empirical research base indicates that STEM provision in ECEC is linked with significantly higher enthusiasm and motivation for science in later life[24] and is predictive of later academic achievement in mathematics knowledge and skills.[25] The introduction of engineering provides a cross-disciplinary foundation that contextualises young children's mathematics, science, and technology learning, and supports meta-cognition.[26 27 28]

Despite this, evidence indicates that STEM in ECEC is often of poor quality[29 30]. Educators report that their initial education does not prepare them to support STEM in ECEC.[31 32] Unsurprisingly, negative beliefs about STEM and poor self-efficacy impact STEM practices in ECEC settings. [33 34] Discipline content knowledge is also weak as that STEM is not a required subject in ECEC initial education.[35 36]

A play based approach to STEM Education is recommended in the early years. Given the fundamental role of play in ECEC philosophy and praxis, pedagogical approaches for early STEM should productively build on play, supporting intentional and appropriate scaffolding that fosters conceptual understanding of STEM.[37 38] A proficiency in the fundamentals of each discipline is the first step toward competent integrated STEM education in ECEC.[39]

6. STEM Education in Primary Education

Given the longstanding evidence of dips in enthusiasm relating to traditional mathematics and science in the early post-primary years,[40] it is important to build a range of experiences of STEM subjects in the primary grades if we are to avoid the significant fall-offs in take-up of STEM subjects later in schooling and at third level. Integrated STEM approaches are commonly suggested as a key route for achieving this. The most recent TIMSS analysis[41] indicates that several participating countries have incorporated some focus on integrated STEM in their curricula.

STEM Education in primary schools is typically facilitated within traditional subject boundaries and in integrated STEM projects. STEM projects have been seen as sites in which learning from multiple subjects can be applied. Another route into integrated STEM is to see STEM work as sites through which concepts, skills and ways of working in the STEM disciplines emerge.

At Primary level, research has demonstrated that children develop improved sense of school-learning as connected with the world outside of school through integrated STEM approaches. They also develop awareness and experience of authentic problem-solving connected to phenomena in the world and to children's lived experiences, with mathematical, scientific, engineering and technological competences brought to bear in combination in the service of problem solving. There is also evidence that better learning outcomes in the STEM disciplines can be achieved through integrated STEM approaches.[42]

However what STEM education can consist of is poorly understood, and the research base points to differences in STEM implementation, depending on whether they proceed from Maths/Science/ Technology perspectives. Critiques have noted dangers of limited specific attention and learning of disciplinary concepts and skills within integrated STEM models.[43] Most commonly expressed is that primary teachers' content knowledge linked to the STEM disciplines tends to be weak, and limits the potential of implementation of integrated STEM.[44]

Few curricula worldwide have gone down the route of fully integrated STEM teaching. We would suggest that this is because of the dangers of missing key concepts and the coherent trajectory of ideas within the disciplines. Given these concerns and the need to build, over time, teachers' confidence and competence with STEM teaching, the most common models of integrated STEM teaching involve STEM projects interspersed across Mathematics/Science/Technology/general timetable slots. Planning is critical for age-appropriate foci and incorporation of content and skills from across the STEM disciplines.

7. STEM Education in Post Primary Education

At Post Primary level, STEM Education is traditionally facilitated within subject boundaries and integrated STEM is uncommon. Current approaches to assessment and a need to further develop teacher capacity in the discipline areas are perceived as inhibiting more adoption of integrated STEM. Although students in Ireland perform well in mathematics and science in international and national assessments (e.g. Ireland ranked 16th and 17th out of 37 OCED countries in PISA 2018), there are concerns. Irish students perform better on knowledge and procedural based tasks than in tasks requiring higher levels of cognitive thinking[45]. Studies indicate that post-primary schools in Ireland overly focus on the teaching of the knowledge and skills students need to perform well on state examinations.[46] Baird et al. (2014)[47] for example, note that teaching at Senior Cycle "is geared towards what tends to be on the examination, as opposed to embracing the breadth of the syllabus and working outside the confines of what is presented year-on year in the examinations" (p. 79).

Teacher practice in the classroom is affected by the disciplinary knowledge of the teacher in combination with their knowledge of how to teach the subject; the quality and the level of a teacher's qualification is deemed paramount[48]. Recent changes in the Teaching Council imply that science teachers no longer require teaching credits in all three Junior Science subjects[49]. This has significant implications on teacher content knowledge for Junior Cycle teaching which in turn has implications for development of pupil conceptual knowledge and uptake of subjects at senior cycle (pupils tend to pick subjects in which the teacher is an expert). Out-of-field teaching whereby teachers are assigned to teach subjects which do not correspond to their education[50] remains an issue to be considered. While there has been a substantial decrease in the prevalence of out-of-field teaching of mathematics and physics in Irish post-primary schools since the introduction of the government funded professional diplomas in out-of-field mathematics and physics teaching, 25% of post-primary mathematics teachers in Ireland do not have a mathematics qualification.[51]

Teachers remain concerned about insufficient time allocated to teaching both in mathematics[52] and in science subjects - particularly for practical and laboratory work at Senior Cycle.[53]

In summary, these concerns raise risks with restricted experiences for students, with traditional procedural teaching prioritised over investigation or enquiry-based learning and teaching and, thus, deep understanding. These issues limit the knowledge and skills that students are taught at school, and also to their ability to apply such skills to real-life problem-solving. They feed into the decreasing enthusiasm for STEM learning that leads to drop offs in numbers continuing with STEM subjects at senior cycle. In particular, low numbers opt to take chemistry, physics, engineering and applied mathematics with significantly lower numbers of females choosing to study physics, engineering and applied mathematics.

Finally, inclusion of integrated STEM is also recommended at post primary level. Integrated STEM approaches can support children's transition from primary to post primary school as well as their preparation for classroom based assessments in Junior Cycle science and mathematics. Similarly, integrated STEM in Transition Year supports participation in Leaving Certificate STEM subjects. Across both First Year and Transition Year; integrated STEM works to builds a STEM culture in schools and students STEM identity, promotes awareness of STEM roles and career opportunities and role models, and fosters equity and inclusion in STEM education. Student participation in national STEM events such as Scifest[54] and the BT Young Scientist and Technology Exhibition[55] develops confidence and interest in STEM.

8. Conclusions

Arising from this discussion, we would like to draw the following set of conclusions:

- STEM incorporates disciplinary knowledge, values, skills and processes in Science, Technology, Engineering and Mathematics while also promoting an applied, problem-solving orientation learning across and between these disciplines i.e. integrated STEM
- STEM education provision in disciplinary and integrated forms is premised on teachers having the necessary content knowledge and confidence across the STEM disciplines and the ability to integrate the STEM disciplines in order to provide meaningful learning opportunities for their students
- The introduction of STEM education at an early age from an early age is critical to the development of the foundations of skills, knowledge, beliefs, confidence and self-efficacy in STEM
- To increase diversity in STEM, it is critical that all students have access to the widest range of STEM subjects in schools and to teachers who are appropriately qualified to teach these subjects

However,

- Pre-primary and primary teachers' content knowledge linked to the STEM disciplines tends to be weak, and limits the potential of implementation of integrated STEM
- At post primary level, current approaches to assessment and a need to further develop teacher capacity in the STEM disciplines imply traditional procedural teaching is prioritised thus limiting the knowledge and skills that students are taught at school, and their ability to apply such skills to real-life problem-solving
- Changes in the Teaching Council Registration requirements imply that science teachers no longer require teaching credits in all three Junior Science subjects. This has significant implications on teacher content knowledge for Junior Cycle teaching which in turn has implications for development of pupil conceptual knowledge and uptake of subjects at Senior Cycle.

As stated at the outset of this submission, a key focus in the STEM Implementation Plan is *on reviewing, with a view to enhancing, the supports in place to ensure our teachers feel confident to embrace STEM (p.11)*. To achieve this ambition, increased attention and resources are required to develop teacher capacity in STEM education across all levels of schooling and beginning in early childhood.

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IOP | Institute of Physics In Ireland 2023/049

Written Submission to Oireachtas Education Committee
Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

1. Introduction

1.1 The Institute of Physics (IOP) is the learned society for Physics in Ireland and the United Kingdom. The organisation works to promote the role of Physics and STEM in tackling global issues and positioning Ireland and the UK for a new industrial era of science, technology and engineering.

1.2 The aim of the IOP is to transform the physics landscape for Ireland and ensure a thriving physics ecosystem that will contribute to innovation, discovery, research, growth and enterprise. Committed to the growth of the organisation in Ireland and Northern Ireland, the IOP is developing its European base in Dublin and has expanded its workforce.

1.3 As the IOP strives to expand its contribution to the public policy discussion in Ireland, it has undertaken work in a number of important and relevant areas to the inquiry:

i. *Limit Less campaign* to support young people to change the world by continuing physics beyond the age of 16,
ii. *Physics and the Economy* Measuring the value of physics-based industries Ireland,
iii. *Paradigm Shift* on research, development and innovation,
iv. *Workforce Skills* on the job market and physics skills (summary),
v. *Subjects Matter* on how to deliver the best physics education, and
vi. *Solving Skills* on physics-related apprenticeships (summary, Ireland-specific findings on p. 77)

2. Education, Physics and Our Society – Realities and Misconceptions

2.1 The centrality of physics to future innovation and the role of physics in the economy and workplace is not fully appreciated; physics is everywhere in our life and economy but not commonly recognised as such. Physics is central to industries such as advanced manufacturing, engineering, computing/big data, pharmaceuticals, energy, and telecommunications. However, the link to physics within these sectors is not made in the public mind and sometimes by employers themselves.

2.2 The present contribution of physics to the economy is significant and has the potential to be even more so. In 2019 Physics Based Industries (PBIs):

i. contributed €29 billion to Ireland's Gross Value Added (GVA) and 9% of its GDP.
ii. had a turnover of €80 billion and the sector is larger than the construction and retail sectors combined (€69 billion in total).

iii. represented over 20,000 business that employ nearly 200,000 people of which 98% are Small to Medium Enterprises (SMEs).

2.3 In terms of future contribution, PBIs are central to the national ambition to increase R&D and are leading the way with €1.4bn of investment in 2019 – 40% of all Irish business R&D even though they account for less than 10% of all businesses. If the jobs growth trend is maintained, PBIs would create a further 80,000 high value jobs in the next decade.

2.4 Physics suffers from a number of harmful misconceptions that have a negative impact upon it throughout the education and skills pipeline. Current and future opportunities will be missed without significant improvements in the education and skills pipeline. Below the submission sets out what the IOP considers to be best practice at each stage.

3. Physics – The Pipeline Journey

Primary Level

Inclusion

3.1 The path to future inclusion begins at Primary level and is where stereotyping of groups and societal bias is reinforced. The curriculum and teaching in schools need an inclusive, consistent approach to subjects, choices, and future careers from the beginning.

Curriculum and Support

3.2 Primary education will begin to establish the educational preferences of a child. Therefore, it is important to provide some introduction as early as possible; the IOP believes in a three-part approach:

i. STEM Inclusion in the Primary Curriculum
ii. Teaching materials support.
iii. Inclusion in Teacher Training and Continuing Professional Development (CPD).

3.3 The IOP, in partnership with the Learned Societies of Chemistry and Biology, has been working with an expert panel on the place of science within a Primary curriculum. Its work is nearing completion and can share its results on its launch, the Committee may find it of value to compare its proposals against present curriculum arrangements.

3.4 A curriculum alone does not deliver change in our education system but in conjunction with the empowerment of teachers and schools to support under steps 2 and 3, above. In its absence, most teachers will likely opt for the elements of STEM that they are most confident in their own abilities to teach. With the common misconceptions about physics, it is our belief a lack of teacher support has/would result in physics being one of the more neglected STEM subjects.

Secondary Level

3.5 In 2021, 57,952 students took the Leaving Certificate examinations, with 29,290 defined as female and 28,662 as male. Amongst those entrants the uptake and breakdown across the three sciences at the Higher level was as follows:

Subject	**No. of entrants**	**% of all entrants**	**Male**	**% of all males**	**Female**	**% of all females**
Biology	30,677	53%	11,324	40%	19,353	68%
Chemistry	8,794	15%	3,522	12%	5,272	18%
Physics	7,210	12%	5,149	18%	2,061	7%

3.6 Secondary education is when most pupils will have their first educational experience of physics. The IOP is committed to a positive and inclusive experience for students, with education of the highest quality available to all students. These statistics would support the conclusion these aims are not being fulfilled.

Inclusion

3.7 Beyond the significant gender gap in those taking up physics at Leaving Certificate level, the IOP knows from experience that there is underrepresentation of other groups, such as some socio-economic groups, minority ethnic communities, LGBT+ people and people with disabilities. The IOP believes that the Committee should advocate for a fuller spectrum of data to be collected and published to identify and tackle underrepresentation.

3.8 Our Limit Less campaign has four policy goals on teacher standards, training, school inspection and whole school equity plans. The IOP believes every school should be mandated to have a whole-school equity plan that creates an inclusive learning environment for all young people. Research has shown that equality needs to permeate the culture and approach throughout the school and every stage of education to overcome underrepresentation.

3.9 In Great Britain, the 2010 Equality Act placed equality duties on schools with many opting for Whole School planning to achieve them. Survey feedback from teachers recognises it as a key tool for positive change and more equitable outcomes. The Committee should consider examining the legal framework and different approaches to implementation seen in England, Scotland and Wales and should consider a comparable future approach.

Quality

3.10 However, there are several barriers to supporting the growth of physics in schools:

i. Teacher specialism – the Subjects Matter report sets out how high-quality teaching from a *subject specialist* is one of the single most important factors in pupil experience, attainment and whether or not they pursue the subject post-16. Within the Irish system there are no physics-only teachers with a teacher often delivering a small number of different subjects. This reduces the chances of a teacher having a physics specialism and means their time for CPD has to be spread across all their subjects. Equally, the high demand for physics skills reduces the future teacher pool further. They will likely have more attractive alternative offers unless they have a vocation to teach. Few physics undergraduate, postgraduate and PhD students intend to go into teaching, especially considering the financial incentives to work in other sectors; research in England highlights the role that financial incentives can play in teacher supply, including in shortage subjects. Thus, we believe the Committee needs to examine how physics teaching can be made a more attractive option and how non-specialists can receive full subject specific training before commencing teaching.

ii. Continuing Professional Development – The Professional Development Service for Teachers (PDST) recognises the challenges of Physics teaching, but it is IOP's understanding that staffing issues have impaired its ability to act substantively and will often refer teachers to the IOP. The IOP therefore must act as the main provider of CPD for Physics teaching through experienced coaches running a regular online and in-person programme supplemented by our annual teacher's conference 'Frontiers of Physics'. We would ask the Committee to consider how this necessary work could be supported in future and at greater scale, and specifically call on the Ireland Government to invest in subject-specific CPD.

iii. Equipment – Physics and its teaching requires specialised demonstration equipment as a key aid to the student experience. This equipment has a greater cost, technical support and space requirement than other science subjects and much of it has a single function that limits its uses outside of physics.

Availability & Opportunities

3.11 Physics is not available to all at Leaving Certificate level. We would encourage the committee to seek data on the availability of physics and other STEM subjects in all schools.

3.12 From the IOP's engagement with students we expect this data to show not only individual schools with no physics provision especially in rural areas. It is an issue regularly raised in our engagement with rural students that despite wishing to continue physics it is neither available at their school nor neighbouring ones.

3.13 There are three additional factors that suppresses demand and supply of physics:

i. Curriculum – Physics contains a large number of disciplines and areas of potential focus within it. The present curriculum has a narrow view of physics and thus does not properly represent the full range of opportunities physics could lead to. Course materials also need to be made inclusive.

ii. Careers Awareness and Advice – There is a lack of awareness of the wide number of jobs physics can lead to amongst teachers and parents. The Committee may wish to examine the quality and consistency of career advice in schools. The IOP Limit Less Careers booklet has sought to tackle this as well as harmful stereotypes.

iii. Higher Only – As highlighted earlier, many jobs using physics skills at technical level do not need degree level education. However, the IOP believes this is not widely known or understood and, as a result, it is a common misperception that the Higher pathway is the only route into physics jobs and careers. Instead, the Ordinary pathway would offer many people a more relevant route into physics based apprenticeships but is not offered. Further information on the barriers to growth of physics-related apprenticeships can be found in our recent report *Solving Skills* report.

Tertiary level

3.14 In the tertiary sector there are four issues the IOP would highlight to the Committee:

i. Inclusion – if the cohort of students from schools is unrepresentative then this flows into universities. However, the IOP does not consider this grounds for inaction and on the issue of gender developed the Juno award to encourage outreach and engagement into the education system to tackle inequality. The University of Limerick Physics Department was the first in the Republic of Ireland to achieve Juno Champion status and Athena SWAN Silver award. Its work in local schools led to significant improvements in representation and the Committee may wish to consider it as a tertiary level case study.

ii. CERN Membership – Ireland's non-membership of CERN denies student placements, research positions and career opportunities to Irish students, researchers, and academics. It is out of step with every other major European economy and the IOP believes the long-term opportunities in joining should be considered comparable to the gains from Irish membership of the European Space Agency. The IOP would encourage the Committee to add its voice to the call to join CERN.

iii. Course costs – The delivery of courses have significant cost variations and physics is among the more expensive to deliver. Effective delivery requires more teaching and laboratory hours and highly specialised and expensive equipment. This makes it potentially more vulnerable to cuts and more reliant on raising external funding to maintain and develop its equipment and research facilities for students and staff.

iv. PhD Stipends – The IOP fully supports the Government target on R&D spending but without researchers there will not be the talent to do the work. The IOP believes the stipend is insufficient especially in the Greater Dublin area. PhD opportunities are declined or not completed because of this, this means years of investment in knowledge and skills do not reach their full potential. The IOP would encourage the Committee to examine the policy options and recommend an uplift.

2023/050(i)

Statement to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

27 February 2023

Executive summary

In this submission to the Joint Oireachtas Committee, the National Apprenticeship Office sets out the substantial contribution apprenticeships make to STEM education and careers in Ireland and makes three recommendations. These are firstly to ensure that promotional campaigns include STEM apprenticeships; secondly to develop additional targeted initiatives for primary and second level schools; and last to plan an additional drive to enhance diversity and inclusion in STEM apprenticeships. With these practical steps the education system will be able to further harness the investment and contribution of apprenticeships for the benefit of learners, the enterprise community and our society and economy as a whole.

1 Introduction

The National Apprenticeship Office welcomes the opportunity to make a submission to the Joint Oireachtas Committee on Education, Further and Higher Education, Research, Innovation and Science on the future of STEM in Irish education.

This document is set out in three sections. Following the introduction, section 2 expands on the contribution apprenticeships make to STEM education in Ireland. Section 3 sets out three recommendations for consideration by the Committee. An appendix to the document lists 40 national STEM apprenticeships currently available and a further 12 at development stage.

The National Apprenticeship Office was established jointly by the Higher Education Authority (HEA) and SOLAS in 2022 to oversee and manage the national apprenticeship system as a whole and to implement the *Action Plan for Apprenticeship 2021-2025.* The *Action Plan* aims to establish apprenticeships as a major route to skills development in Ireland. It includes a goal of at least 10,000 apprentice registrations by 2025. This would correspond to almost doubling apprentice registrations over a five-year period 2020-2025. Over €200m is being allocated annually by Government to support apprenticeship training.

Apprenticeships are work-based programmes, with learning on-the-job combined with learning in an educational setting. Apprentices are employed for the duration of their training. They earn a salary while gaining their qualification. Apprenticeships lead to major awards on the National Framework of Qualifications.

In response to Government policy since 2014 on expansion of apprenticeships there are now 66 national apprenticeship programmes available, leading to major awards at six levels of the ten levels of the Framework, from Level 5 (certificate) to Level 10 (Phd).

The national apprenticeship system is making a substantial contribution to STEM in Ireland. Of the 66 apprenticeship programmes available, 40 are in STEM areas, training 20,905 apprentices as at the end of 2022. This corresponds to 79% of the overall population of 26,325 apprentices. In addition to the 40 STEM apprenticeships available, there are 12 more STEM-related programmes in development.

2 The contribution apprenticeships make to STEM education in Ireland

The apprenticeship route provides four distinct advantages and opportunities for advancement of STEM education. Firstly, **enterprise has a lead role in the development and design of apprenticeship programmes**. All apprenticeships developed since 2016 are 'industry-led'. In advance of reaching the development stage evidence of broad-based industry demand is required, including from sources such as the Expert Group on Future Skills Needs. Each apprenticeship is coordinated by a consortium with an industry chairperson. Each apprenticeship programme is designed (content, duration, NFQ level, assessment) in close consultation with the industry-led consortium.

Industry oversight remains strong during delivery and ongoing reviews and updates to the programme are undertaken regularly. This core involvement of enterprise has steered development of the large number of STEM apprenticeships currently available and has enabled responsiveness to current and emerging skills needs in areas that include software solutions, data analysis, cybersecurity, manufacturing engineering, industrial electrical engineering. As new technologies emerge, including in the area of artificial intelligence and immersive technologies, the industry-education partnership that underpins the apprenticeship system is uniquely placed to respond.

The second advantage which apprenticeships offer is the **learning which takes place on-the-job**. At least 50% of apprenticeship training must take place in the workplace. Many current apprenticeships are designed to have 70-80% of learning on-the-job. This approach ensures robust and ongoing industry involvement, and it enables the latest technologies and innovation in the workplace to be reflected in apprenticeship learning. Skills and knowledge that are at the heart of STEM education are developed in the practical and real-world environment that is the workplace, skills such as critical thinking, problem-solving, analytical skills, as well as creativity, collaboration, and innovation.

Thirdly, there is an **opportunity via apprenticeships to increase diversity and inclusion in STEM education**. Initiatives and incentives are in place to encourage more participation by women in apprenticeships where they are under-represented; this includes the majority of STEM apprenticeships, in line with participation in STEM education overall. A gender bursary of €2,666 per apprentice is available to employers who employ women on apprenticeship programmes where women are significantly under-represented.[1]

Overall, 12% of apprentice registrations in 2022 were women; this is an improvement on previous years where less than 2% of apprentices registering annually were women. However, the overall figure of 12% is not reflected in registrations on STEM apprenticeships where less than 5% of STEM apprentices were female in 2022. This is well below the figures for female participation in STEM education across academic further and higher education programmes.

Opening up access to apprenticeships for people of all backgrounds and abilities is a core component of the *Action Plan for Apprenticeships 2021-2025*. An access and inclusion group has been established in Quarter 1 2023 to support the National Apprenticeship Office to take practical steps in this regard, including allocation of an additional financial bursary for potential apprentices who are experiencing social and/or economic disadvantage, such as young people who have come through the care system, Travellers, refugees and other under-represented minorities.

The access and inclusion group will also advise on apprenticeship opportunities for people with disabilities. At present there is little information gathered on how learners with a disability experience or feel supported during their apprenticeship training.

Finally, STEM apprenticeships provide an important and practical **means to deliver on vital Government policies and strategies**. These include Housing for All, the National Development Plan 2040, and the Climate Action Plan 2023. The growing number of apprenticeship offerings are well placed to provide a strong pipeline of skilled workers in the areas required for the successful implementation of these policies.

The Housing for All initiative was launched in September 2021 and highlights the need to grow the number of skilled trades people working in Ireland. Analysis by the Expert Group on Future Skills shows that the apprenticeship system is the main route of entry to most of the required occupations. This reinforces the importance of STEM apprentices in providing a steady supply of skilled workers required in the construction sector. Expanding the training of skilled construction workers is particularly important in terms of meeting the needs of a growing population.

The National Development Plan 2040 will see major investment in key strategic infrastructure projects throughout Ireland. There are several Civil Engineering

[1] A minority gender is identified as a gender with an underrepresentation of at least 20% in a specific programme. For example, the gender bursary is available to all Electrical apprentice employers as more than 80% of all Electrical apprentices in 2022 were male.

apprenticeships in development stage, with qualifications ranging from Level 6 (Certificate) to Level 9 (Masters). These apprenticeships will support the development of the skills required to deliver the projects set out in the 2040 Plan.

The Climate Action Plan 2023 outlines the need to “support and accelerate the design, development and implementation of apprenticeships meeting green skills for the future”. The launch of the Wind Turbine Maintenance Technician programme in 2022 is the first dedicated greens skills apprenticeship in Ireland. Apprentices will contribute towards the needs of the growing Irish renewable and sustainability energy sector, developing green skills and expertise in the areas of retrofitting and near zero energy buildings (NZEB).

3 Recommendations to the Committee

The National Apprenticeship Office will continue to help drive STEM education in Ireland via apprenticeships and makes three recommendations to the Committee on apprenticeships and STEM-related education in Ireland, as follows:

(i) Ensure promotional campaigns include STEM apprenticeships // Based on the experience of promoting apprenticeships over recent years, there is still a gap in understanding and awareness among the public of the range of exciting learning and career opportunities apprenticeships offer in STEM areas. An inclusive and collaborative approach on promotion of STEM education opportunities that includes apprenticeships should be developed, to reach school leavers, current employees and those returning to the labour force, and harnessing the very influential enterprise community in Ireland.

(ii) Develop additional targeted initiatives for primary and second level schools // The pace at which apprenticeships are being developed is growing year on year, and within 1-2 years it is likely that up to 100 programmes will be available, with a large proportion of these in STEM areas. Schools, school principals, teachers and guidance counsellors play a key role in developing awareness of STEM education and apprenticeship opportunities. A coordinated programme of taster courses, competitions for teams and individuals, showcase events, briefings for staff as well as students is needed.

(iii) **Additional drive to enhance diversity and inclusion in STEM apprenticeships //** It is recommended that additional effort is invested in increasing access and inclusion in STEM apprenticeships, building on the work already underway. Targets for STEM participation in terms of gender and for other groups who are under-represented could be considered. Practical initiatives could include an awards programme for apprentices and/or pioneering employers.

National Apprenticeship Office, 27 February 2023

Appendix

Table 1 STEM apprenticeship programmes

STEM Programmes (52)			
Agricultural Mechanics	Engineering Services Management	Lean Sigma Manager	Polymer Processing Technology
Aircraft Mechanics	Equipment Systems Engineer	M.A.M. F	Principal Engineer
Arboriculture	Farriery	Manufacturing Engineer (L7)	Refrigeration & Air Conditioning
CGI Technical Artist	Geo Driller	Manufacturing Technology (L6)	Sheet Metalworking
Construction Plant Fitting	Heavy Vehicle Mechanics	Metal Fabrication	Software Developer Associate
Cybersecurity	Industrial Electrical Engineer	Motor Mechanics	Telecoms & Data Network Technician
Cybersecurity Practitioner	Industrial Insulation	Network Engineer Associate	Toolmaking
Electrical	Instrumentation	OEM Engineer	Vehicle Body Repairs
Electrical Instrumentation	Laboratory Analyst	Pipefitting	Wind Turbine Maintenance Technician
Electronic Security Systems	Laboratory Technician	Plumbing	Wood Manufacturing & Finishing
Adv Quantity Surveyor L9	*Civil Engineering L8*	*Immersive Technology L6*	*Precision Machinist & Quality Control L6*
Civil Engineering L6	*Civil Engineering L9*	*Intl Financial Services Adv Specialist L9*	*Robotics & Automation L6*
Civil Engineering L7	*Digital Marketing & Media L6*	*Manufacturing Data Integration Engineer L7*	*Software Solutions Architect L9*

Note: apprenticeships in italics are in development stage.

Table 2 STEM apprentices (2016-2022)

STEM	2016	2017	2018	2019	2020	2021	2022
Registrations	3252 *(85%)*	4037 *(83%)*	4491 *(80%)*	4855 *(79%)*	4055 *(76%)*	6286 *(73%)*	6094 *(74%)*
Live Population	9261 *(89%)*	11134 *(87%)*	12893 *(84%)*	14624 *(82%)*	15732 *(80%)*	19178 *(79%)*	20905 *(79%)*

Note: percentage share of total in parenthesis

Table 3 Female STEM apprentices (2016 – 2022)

Women in STEM	2016	2017	2018	2019	2020	2021	2022
Registrations	9 *(0.3%)*	22 *(0.5%)*	77 *(1.7%)*	108 *(2.2%)*	121 *(3.0%)*	218 *(3.5%)*	283 *(4.6%)*
Live Population	30 *(0.3%)*	41 *(0.4%)*	101 *(0.8%)*	200 *(1.4%)*	295 *(1.9%)*	459 *(2.4%)*	641 *(3.1%)*

Note: percentage share of total in parenthesis

National Council for Curriculum and Assessment (NCCA)

Written Submission for the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

Future of STEM in Irish Education

February 2023

1. Introduction

The National Council for Curriculum and Assessment (NCCA) was established in 1987 as a successor to the Curriculum and Examinations Board (CEB) and was reconstituted as a statutory body in July 2001. The remit of the Council, outlined in the Education Act (1998), is to advise the Minister for Education on matters relating to the curriculum for early childhood education, primary and post-primary schools, and the assessment procedures employed in schools and examinations on subjects which are part of the curriculum (Section 41.1 a, b).

The Council is a representative structure and is appointed by the Minister for Education for a four-year term. It has 26 members who represent teachers, students, school managers, parents, business interests, trade unions, the Irish language sector and other educational interests. Other members include representatives of the Department of Education, the State Examinations Commission, a nominee each of the Minister for Education and the Minister for Children, Equality, Disability, Integration and Youth. The current Council was appointed in March 2022 until February 2026.
NCCA has a full-time executive staff, led by a Chief Executive. Funding is by way of a grant from the Department of Education.

2. Curriculum and assessment development process

The Council's work is progressed through a number of representative structures. This representation brings significant experience and expertise and supports the development of high-quality advice on curriculum and assessment. In addition to the Council, and under its guidance, work is progressed through boards and development groups. Council also uses other structures such as working or standing groups to advance aspects of its work.

NCCA's vision is *to lead and sustain developments in curriculum and assessment that are sufficiently far-reaching so that all children and students can experience and benefit from enjoyable, engaging, relevant and appropriately challenging experiences to support learning, living in, contributing to, caring for, and working in a changing world* (2022, p.14). Guided by this vision, NCCA develops curriculum and assessment advice in an iterative and responsive manner through close engagement with learners, teachers, practitioners, parents and school leaders; through extensive public consultation; by drawing on research evidence, good practice and international experience; and through ongoing discussion and deliberation by the Council, boards and development groups.

Throughout the work, the Council remains attuned to new opportunities to innovate and to new national policy priorities as they arise. NCCA also supports educational change in settings and schools by developing support materials such as examples of practice, examples of student work, assessment guidelines and planning resources, and by working with those introducing new developments to practitioners and teachers.

As set out in its *Strategic Plan 2022-2025*, NCCA's work in early childhood, primary and post-primary education is guided by a clear, overarching purpose of education. This purpose is to

- *enable all young people to learn for and enjoy the 'here and now',*
- *support holistic development and help all young people to live in, contribute to, care for and work in a changing world,*

- *nurture respect and dignity for all, and*
- *create lovers of learning* (NCCA, 2022a, p.4).

The Council's work in STEM education is also informed by wider government policy, including the *STEM Education Policy Statement* (2017a) and the *Digital Strategy for Schools to 2027* (2022).

3. Early childhood education

Aistear: the Early Childhood Curriculum Framework (NCCA, 2009) is for all children from birth to six years in Ireland. The framework is underpinned by 12 principles and uses four interconnected themes to describe learning and development. The themes are Well-being, Identity and Belonging, Communicating, and Exploring and Thinking. NCCA is updating *Aistear* so that it continues to support high-quality learning and development experiences for young children. The process began in late May 2021 and is being carried out over two phases.

As part of the update, a literature review to support *Aistear's* themes has been published. A key trend emerging from this review is the importance of recognising and naming STEM experiences in daily life (French et al, 2023). Engagement with STEM, in early childhood, is supported through NCCA's involvement, with partners, in the National *Síolta Aistear* Initiative (NSAI), particularly through the development of resources published in the online *Aistear Síolta* Practice Guide. These resources support early years educators in taking an integrated approach to including STEM in the early childhood curriculum, so that young children experience STEM in a meaningful way.

Phase 1 of the consultation focused on inviting the early childhood stakeholders to share their views on what is working well with *Aistear* and how it might be enhanced and updated. The need to include learning in STEM featured in the consultation findings but was not consistently identified as a key priority. The findings show a preference for a greater emphasis on play-based STEM learning and for STEM to have greater visibility, not just in the theme 'Exploring and Thinking', but across all four themes of *Aistear*.

4. Primary education

The curriculum for all primary and special schools is being redeveloped by NCCA. The *Primary Curriculum Framework*, which will be launched by Minister Foley in March 2023, provides the foundation for a redeveloped curriculum in the coming years. The framework is underpinned by eight overarching principles, one of which is 'Inclusive education and diversity', and it details the curriculum areas and subjects. It introduces Science, Technology, Engineering and Mathematics (STEM) as a curriculum area in stages 1 and 2 (Junior Infants – 2nd class) and Science, Technology, Engineering and Mathematics as subjects in stages 3 and 4 (3rd class – 6th class). The framework also introduces seven key competencies for children's learning. These help enable children to adapt to and deal with a range of situations in school, in their homes and in their communities. Two of the seven competencies are directly related to learning in STEM - 'Being mathematical' and 'Being a digital learner'. The competencies will be integrated across all five curriculum areas and subjects, so that they can support and extend learning in STEM as children become curious, creative, confident and critical users of technology as well as developing and applying mathematical thinking and logic to solve a range of problems. The suggested time allocations for schools working with the curriculum include a category of time called 'Flexible time'. As well as the minimum suggested time for teaching STEM, schools can decide to allocate additional time from 'Flexible time' to learning in STEM or learning associated with the key competencies if they wish to do so.

How the Primary Mathematics Curriculum addresses and connects to STEM

In December 2022, a new Primary Mathematics Curriculum was approved by the NCCA Council. This new curriculum recognises that a child's STEM (mathematical) learning journey begins from birth and that children initially learn STEM (Mathematics) through their interactions and experiences in their home environment. They later build on this learning through early childhood, primary and post-primary education.

At primary level, and as noted above, Mathematics is situated within the Science, Technology, Engineering and Mathematics (STEM) Education area of the curriculum and provides an important foundation upon which to develop and refine children's learning in STEM Education. Rich learning experiences in STEM Education support children to understand fundamental relationships, connections and patterns that are intrinsic to our concept of the world. These learning experiences prepare children for, and enhance their capacity to understand and fully engage with the world around them. As children learn with the new mathematics curriculum, they will be encouraged to make explicit connections with their learning in Science, Engineering and Technology. They will have the opportunity to do so in myriad ways; for example, by engaging in common learning processes such as reasoning, argumentation and problem-solving, and also by applying key mathematical concepts that can enhance their understanding across other areas of learning such as measuring, fractions and spatial awareness. The pedagogical approaches promoted in the new Primary Mathematics Curriculum include fostering productive disposition which helps children persevere with problem-solving; encouraging playfulness with Mathematics; emphasising mathematical modeling for developing meaningful solutions to problems; using cognitively challenging tasks to stretch and challenge children's conceptual understanding; and promoting 'maths talk' to enable children to express their mathematical strategies, thinking and ideas.

To support NCCA in the development of a new primary curriculum for STEM Education, the Institute of Education in Dublin City University has been commissioned to conduct a comprehensive literature review. This research, due for completion in mid-2023, aims to establish:

- the philosophical basis and educational basis for STEM Education
- the evidence base on children's learning and development for the integrated learning in STEM in stages 1 and 2 – junior infants to second class, and the subjects of Science, Technology, Engineering and Mathematics in stages 3 and 4 – third to sixth class.
- in response to curriculum overload, the desired curriculum processes and essential curriculum content (knowledge, skills, values and dispositions) for children's learning and development in Science within the broad primary curriculum.
- the relationship between Science and Technology as a curriculum subject
- the aspects of STEM (knowledge, skills, values and dispositions) that support curriculum integration in stages 1 and 2, and support subject integration in stages 3 and 4.

To further support NCCA in this work, the Council and the Burren College of the Arts jointly facilitated a curriculum consultation event entitled 'STEM Education and the Primary Curriculum' in November 2022. The stakeholders involved in this event were primary school children, parents, teachers, special needs assistants, schools leaders, NCCA staff and other educational stakeholders from a range of organisations, including the Professional Development Service for Teachers (PDST), the Teaching Council, the National Council for Special Education (NCSE) and Education Support Centres Ireland (ESCI). Half the participants were children and young people from primary, post-primary and special schools. The purposes of the event were

- to gain greater insight into the future role and place of STEM Education within the primary curriculum.
- to help develop a consensus around the learning experiences that STEM Education should provide in a redeveloped primary curriculum for children from junior infants to 6th class.

A full report from this event will be published at the end of March 2023 at www.ncca.ie.

5. Post-primary education

Across the post-primary curriculum, a range of curriculum components including subjects, modules, short courses, and Priority Learning Units (PLUs) support the teaching and learning of STEM education. It is important to note that in all cases other than Mathematics, schools have choice and flexibility as to which STEM-related components they offer as part of their curriculum.

Junior Cycle

The *Framework for Junior Cycle* (2015) outlines how teaching, learning and assessment practices can support a quality, inclusive and relevant education that meets the needs of all junior cycle students. Guided by this framework, all subjects for the lower secondary stage of education were redeveloped. The STEM-related subjects of Science, Applied Technology, Engineering, Graphics, Wood Technology, and Mathematics were introduced in schools between 2016 and 2019. Using broad learning outcomes to describe important knowledge, skills and attitudes for students' learning, the curriculum for each of these subjects supports teaching and learning that is relevant, engaging and meaningful for young people.

In addition to revised subject specifications, the Framework for Junior Cycle introduced new curriculum components in the form of short courses and PLUs. The main purposes of the short courses were to afford schools greater flexibility in the design of their junior cycle programme; to broaden learning experiences for students; address their interests; and encompass areas of learning not covered by the combination of subjects available in the school. In 2016, NCCA developed short courses in Coding, Digital Media Literacy, and CSI: Exploring Forensic Science (Level 2) which also support STEM-related teaching and learning. These short courses will be reviewed in 2023 creating an opportunity to further strengthen, where appropriate and relevant, the emphasis on STEM education. NCCA has supported schools and organisations in developing their own short courses in STEM-related areas, such as Computing Fundamentals, Animation, Games and App Design, Robotics, and Skills for a Digital World. The fact the framework allows for short courses to be developed at local level means that there is a mechanism for schools and organisations to develop courses in response to emerging areas linked to the future needs of STEM education.

PLUs are offered as part of Level 1 Learning Programmes (L1LPs) and Level 2 Learning Programmes (L2LPs). These are programmes designed for students with particular special educational needs. The learning outcomes for each PLU are broadly aligned with the Level 2 Indicators on the National Framework of Qualifications and create an opportunity for students to engage in learning that supports their development of skills associated with STEM education.

Senior Cycle

To date, a number of developments have taken place across senior cycle subjects and modules that support STEM education now and into the future. Within the Leaving Certificate Established (LCE) programme, Computer Science can now be studied and has a strong focus on programming and computational thinking as problem-solving strategies. In addition, a redeveloped Applied Mathematics Curriculum is now available to schools and aims to develop students' capacity to use mathematics to model real-world problems.

As part of the Leaving Certificate Applied (LCA) programme, two STEM-related modules were recently redeveloped. These include Mathematical Application which seeks to consolidate and improve students' mathematical knowledge, skills and concepts through practical, analytical, problem-solving applications, and Information and Communications Technology (ICT) which aims to give students a more in-depth exposure to the skills and understanding necessary to use ICT in their future working lives. In addition to the ICT module, the precursor module 'Introduction to Information and Communications Technology' was also redeveloped. This module was intended to develop students' skills and understanding to use computers both now and in the future, and offer students the opportunity to work with computers and bridge the gap before studying the full ICT module.

Further to these developments, the *Senior Cycle Review: Advisory Report* (NCCA, 2022b) was published in March 2022 following the response from the Minister for Education, Norma Foley, TD. The Advisory Report records and responds to the views of teachers, students, parents and stakeholders gathered during the four-year review about how Senior Cycle could evolve to meet the needs of all our young people. One of the three tenets of Senior Cycle reform, as announced by Minister Foley, is to empower students to meet the challenges of the 21st century and the Advisory Report identifies key areas for attention which will be crucial to realising this vision for a redeveloped Senior Cycle. NCCA is currently developing a schedule for review and (re)development of senior cycle specifications which will include curriculum components that form part of STEM education.

Work on subject specifications is guided by a brief agreed by Council. In the case of post-primary STEM subjects, account is taken of the importance of widening the appeal of the subjects in order to meet the targets of the STEM Strategy and re-balance gender uptake. This helps to shape deliberations about what knowledge is of most worth for young people living in a twenty-first century society and about appropriate methods of assessment.

6. External engagement

NCCA also places importance on external engagement to inform the Council's curriculum and assessment work in STEM education, and to positively influence the work of other organisations and structures involved in STEM education. Below are two examples of such engagement.

STEM Education Curriculum Seminar

An in-person curriculum seminar on STEM Education at primary level will take place on 17 May 2023. The seminar is designed to provide the education partners and wider stakeholders with an opportunity to meet to discuss research in the STEM area. The main themes emerging from the seminar will feed into ongoing work on the new STEM Education specification as part of the redevelopment of the primary curriculum. A short report on the seminar will be published at www.ncca.ie.

Department of Education: STEM Education Implementation Advisory Group

The Department of Education's STEM Education Implementation Plan is overseen by an Advisory Group which includes two NCCA representatives. This membership enables the Council to bring its curriculum and assessment expertise in STEM from early childhood, primary and post-primary education to the work of the Advisory Group and to feed the decisions of the Group back into ongoing work on curriculum and assessment.

7. Conclusion

NCCA's work in early childhood, primary and post-primary education is grounded in a commitment to develop curriculum and assessment that can enable all young people to thrive and fulfil their potential through participating in and benefitting from enjoyable, engaging, relevant and appropriately challenging experiences. STEM education, now and into the future, plays an important role in this. The Council's *Strategic Plan 2022-2025* sets out ambitious goals for the redevelopment of the primary curriculum and senior cycle, the updating of *Aistear: the Early Childhood Curriculum Framework* and ongoing support for schools' work with the *Framework for Junior Cycle*. Taken together, this work provides opportunity for a continued strong focus on STEM education for young people.

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All subject specifications, short courses, modules and Priority Learning Units referenced are published on the NCCA's website at www.curriculumonline.ie

IRISH UNIVERSITIES ASSOCIATION

2023/052

The Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science by the Irish Universities Association (IUA)

1. Introduction and Context

The Irish Universities Association (IUA) welcomes the opportunity to provide a submission to the Oireachtas Joint Committee on Education, Further and Higher Education, Research, Innovation and Science on the future of Irish STEM education. Across the IUA's eight university members STEM enrolments have witnessed positive growth despite continued underinvestment in the sector. The universities have a key role to play in increasing diverse participation in STEM and believe that this review provides renewed impetus for investment, cross-sectoral coordination, and greater outreach.

2. Enhancing high-level STEM capacity

Across public higher education STEM enrolments have only marginally increased from 2015/16 to 2021/22. Across engineering, manufacturing, and construction (EMC), information and computer technology (ICT), and natural sciences, mathematics, and statistics (NSMS), the overall proportion of total enrolments has increased during that period from 27.9% to 28.2%. If agriculture, forestry, fisheries, and veterinary (AFFV) is included[1] this increases from 29.6% to 29.9%.

However, while the system-wide data is relatively flat, there have been very encouraging increases in STEM numbers across the eight IUA universities. STEM enrolments have increased from 40,554 to 47,171 during the 2015-2022 period, a positive increase of over 16%. This compares favourably to overall total enrolments in the same universities of 146,514 (2015/16) to 165,725 (2021/22), an increase of 13%. During that same period, the female proportion of total STEM enrolments rose from 13,247 to 17,728, representing a rise from 32.7% to 37.6%.

[1] For the purposes of this submission, we have focused on the three core STEM fields (EMC, ICT, and NSMS) based on ISCED and OECD classifications. We note that the STEM Education Policy Statement also includes health and welfare, which we would view as a distinct field from STEM requiring additional targeted approaches as part of wider reforms.

The existing STEM Education Policy[2] does not adequately include or address the role of higher education; however, we recognise the considerable role of early childhood, primary, and secondary education in shaping motivations, interests, and skills for STEM at tertiary level. Developing curiosity, inquisitiveness and problem-solving throughout the school curriculum will enhance the potential for increased STEM applications and admissions in future. The Policy recognises that this inquisition is fostered 'in-school, out-of-school, and beyond school'. Often our universities are centrally involved in STEM related initiatives and activities that supports this approach, collaborating in partnership with schools, enterprise, government, researchers, and the wider community.

University outreach and engagement within the school sectors, including on initiatives such as Science Week and the BT Young Scientist and Technology Exhibition, as well as supporting many competitions and careers fairs across the country that aim to increase awareness and uptake of STEM related study or employment. Furthermore, STEM educators play a significant role in increasing new knowledge, understanding, and awareness of societal challenges across scientific fields, including climate action, public health, and digital transformation. Academics across our universities are ably meeting the challenges of tomorrow while also nurturing learning and inquiry among the student population.

Mathematics and the natural sciences are core underpinning subjects across STEM fields and there have been positive trends in uptake of higher-level Leaving Cert STEM subjects, including in Mathematics. The continuing upward trend of students taking Computer Science as a Leaving Cert subject is also encouraging. The subject has a wider benefit of developing computational thinking regardless of whether these students choose an ICT programme at third-level or not. The IUA encourages government to ensure Computer Science is offered broadly across the second-level sector and to ensure training for secondary school teachers to upskill within this area is funded. Furthermore, any successor strategy to the Third ICT Action Plan 2017 – 2022 will need to reflect the growing need for digital skills across all disciplines, as well as the work of the universities to embed digital skills across their curriculums, not just in STEM.

The overall scale of the challenge cannot be underestimated, with recruitment shortages across STEM-related industries including in the green economy, cybersecurity, accounting, and pharmaceuticals. Student progression rates in ICT and engineering, manufacturing and construction remain lower than for other disciplines, and while our universities have worked proactively to address this issue, a more integrated approach is required between second and third levels to ensure students are adequately

[2] STEM Education Policy Statement (2019). Department of Education. Available at: https://www.gov.ie/en/policy-information/4d40d5-stem-education-policy/

prepared for progression. While skills gap data is a key indicator of the need to build STEM capacity, developing national strategic approaches to STEM cannot be based on student recruitment alone.

The increasing role of lifelong learning, and a shift in focus to upskilling and reskilling for varied and evolving career pathways, provides a new lens through which to view STEM participation. As well as opportunities to improve career guidance and STEM engagement among primary and secondary level students, there are also increased pathways for mature learners to engage with STEM for the first time or to re-engage with STEM after a period out of education. The IUA MicroCreds project demonstrates the potential for short courses of study that engage learners in higher-level skills, provided by experienced academics, co-created with enterprise, and underpinned by a strong university research culture. For example, there has been a significant upward trend in the proportion of females undertaking part-time STEM courses over the age of 24. Flexible and part-time learning pathways are a crucial opportunity to support women returning to the workplace after a period of care leave or to support women to change careers in to STEM related work. The National Skills Strategy, strengthened enterprise engagement, and a clear plan to spend the National Training Fund surplus, can provide the scaffolding for lifelong learning in STEM.

3. Funding the Future

The OECD recently found that staff-student ratios in Irish higher education have deteriorated from 20:1 to 23:1 and continue to compare unfavourably to European peers, indicating that the capacity of the system to respond to emerging challenges and to cater to a growing student cohort is limited by continued underinvestment. Evidence from the UK[3] suggests that high student-staff ratios in STEM have a greater negative impact on student experiences and outcomes than in other disciplinary fields. This reflects that STEM fields of study often require more contact hours, as well as an academic workforce that carries out a diverse range of intensive roles across student support, laboratories, research and dissemination, practice-based learning, enterprise engagement, and societal outreach.

Funding the Future explicitly seeks to enhance the quality and international standing of our higher education system and a key part of that includes bringing staff-student ratios more in line with European peers. Addressing the core funding deficit would provide higher education institutions with greater capacity to strategically plan enhancements for STEM capacity and provide greater agility to respond to related skills need.

[3] Elif Kara, Mirco Tonin, and Michael Vlassopoulos (2021). Class size effects in higher education: Differences across STEM and non-STEM fields. Economics of Education Review. Volume 82, 102104, ISSN 0272-7757, https://doi.org/10.1016/j.econedurev.2021.102104.

The first instalment of the €307m funding requirement identified in Funding the Future was, at €40m, considerably less than that required to make any meaningful impact. It is essential that, in line with Funding the Future ambitions, the urgently needed investment of €307m is fully addressed over the next two budgets with at least €150m provided in Budget 2024. This would, among other benefits, support universities in sustaining core delivery across STEM, further strengthening and pursuing strategic development in these disciplines, and sustaining agility and good practice.

4. Capital Investment

STEM-related programmes by their nature tend to have higher capital investment requirements than many other areas as a result of additional facility and equipment needs. STEM covers a diverse range of disciplines and courses, each with particular resourcing needs, from specialist built and outdoor facilities, as well as equipment, ongoing materials costs, and a growing need for digital capacity. In addition, STEM facilities and equipment can become obsolete at a faster rate due to emerging technologies and approaches.

Furthermore because of such specialist needs there tends to be less capacity to absorb additional student numbers within existing facilities in comparison to other areas where dedicated laboratory space or access to specific equipment or facilities may not be required. As noted above IUA universities have absorbed a significant number of additional STEM enrolments over the period from 2015/16 to 2021/22 and the capacity to continue to expand student numbers in these areas is now being constrained by lack of capital infrastructure and equipment.

There has been a significant lack of capital investment in IUA universities since the onset of the financial crisis, resulting in sustained pressure on campus spaces and facilities for teaching and learning, research, and student services. Over the past decade student numbers in the higher education sector have grown by 25%. Exchequer capital funding available to IUA universities over that period however has effectively been limited to two funding calls of c. €80m each under the Higher Education Strategic Infrastructure Fund. In the absence of Exchequer funding, universities have had to borrow heavily over this period to meet this increase in capital infrastructure needs. Some universities are now at the end of their borrowing limits and will not be able to meet the expected demographic increases coming over the next decade.

Significant Exchequer capital investment in IUA universities is now required to meet the demographic pressures and changing needs of students. In the absence of that funding, the continued capacity of universities to expand STEM provision and produce high quality graduates will be significantly impacted.

5. Research and Innovation

The development of a research funding agency is an exciting opportunity to enhance links between higher education, schools, and the community. Championing the role of university researchers across the STEM disciplines, as well as engaging wider society in the role of STEM in addressing societal and economic needs can be better supported as a result. Irish universities have performed strongly in research and innovation, especially in securing recent EU Horizon 2020 and Horizon Europe funding. These successes build on the capacity of our universities to develop research-informed programmes at undergraduate and postgraduate levels, as well as to develop short courses such as micro-credentials to meet emerging skills needs. Given the previously acknowledged difficulties in meeting the targets for increased postgraduate enrolments set out in Innovation 2020 and the ambitions now set out in Impact 2030, the importance of increased investment in researchers is critical. Without increased opportunities and visibility for research talent, championing STEM to young people and across all levels of education will be hampered. Furthermore, such coordinated actions across education can enhance evidence-based and research-informed teacher education for STEM.

The ongoing review of State Supports for PhD Researchers is an opportunity to consider the full progression of students from primary through to research. An estimated 9 in 10 PhD[4] graduates enter industry and professional occupations, cultivating skills and capacity for cutting-edge research between our universities and enterprise. Doctoral education provided by our universities must meet an ever-growing need for research personnel across academia and industry. For example, 80% of natural sciences, mathematics and statistics PhD graduates felt their qualification was relevant or very relevant to their job[5] highlighting the need for high-level research experience for the knowledge economy.

6. Diversity and Inclusion

Institutional and disciplinary strategies for gender equality and inclusion have begun to close the gap between male and female student participation, however, as noted above greater coordination between second and third level is required to achieve parity. Encouraging women and marginalised cohorts to enter STEM courses or careers will rest on strengthening engaged citizenship, broadening understanding of what STEM entails, and improving career guidance to address perceptions of particular fields as masculine in nature. The IUA would encourage further focused EDI initiatives in STEM that can more deeply consider gender stereotyping and inequalities, holistically examining why

[4] Ireland's Higher Education Research System: A Review by the Higher Education Research Group (2021)
[5] Graduate Outcomes Survey - Postgraduate Research Graduates (GO 2021) | Statistics | Higher Education Authority (hea.ie)

some disciplines are dominated by one gender identity and the actions that can be taken to address this imbalance going forward.

Funding initiatives are very much welcome, including the €3.7million allocated by Ministers Harris and Foley in June 2022 to increase diversity and inclusion, as well as public understanding of STEM. Of the 47 projects funded, IUA universities are spearheading 28 of these, demonstrating the significant need to invest in our staff and students to champion such initiatives. Indeed, public understanding and awareness of STEM and increasing diversity in STEM go hand-in-hand, ensuring that women and marginalised groups are supported in their fields of expertise as role models.

The Maynooth University STEM Passport to Inclusion, which supports young working-class women to engage with STEM, is a key example of the potential of targeted initiatives. A post-programme participation survey that 79% of participants were considering a career in STEM, and 79% of students said they were now considering studying a STEM subject. The role of female champions and mentors was also of critical importance, with 95% of students indicating that mentors engaged with the project had changed their view of STEM.

The IUA strongly supports the recently published National Access Plan that recognises diversity and inclusion is not solely based on widening access, but also rests on ensuring that students from under-represented and marginalised backgrounds are supported to succeed and to achieve positive outcomes for further study and their career pathways. While HEA data indicates overall female participation in STEM courses stands at approximately 33%, this number is considerably higher across access routes, including HEAR and DARE, as well as in foundation courses.

7. Key Recommendations

- To increase capacity in higher education for enhanced STEM provision, as well as outreach and engagement activities, government must fulfil as a matter of urgency the €307million funding commitment under Funding the Future, with at least €150m to be provided in Budget 2024.
- A step change in Exchequer capital investment is required for higher education institutions to address the immediate capital investment needs of the sector and to meet planned demographic growth over the rest of this decade. Such an increase in funding would help to increase capacity across STEM disciplines and support essential digital transformation projects.
- A coordinated action plan that is inclusive of the significant role that higher education plays in meeting STEM skills needs is required cross-sectorally, through primary to tertiary. The plan for an integrated tertiary sector is an opportunity to achieve this aim.

- A broader strategy for lifelong learning, including re-skilling and up-skilling, is required to unlock the potential for STEM participation and inclusion across an individual's educational and careers journey.
- The new research agency should work proactively to increase funding for postgraduate research places across STEM disciplines.

2023/057

ISSU
IRISH SECOND-LEVEL STUDENTS' UNION

ISSU Oireachtas Submission on the future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

Irish Second-Level Students' Union
Aontas Daltaí Iar-bhunscoile na hÉireann
Representing, Uplifting and Defending Student Voice

Introduction

The Irish Second-Level Students' Union, hereafter referred to as the ISSU, is the national representative body for second-level students in the Republic of Ireland. The ISSU aims to foster a stronger student voice at all levels of the education system. It is our firm belief that second-level students should be involved in all matters that directly affect them and be respected as equal stakeholders in their education.
Our goal is to assist in developing a school system that fully empowers students as partners in their education and give.

Executive Summary

The ISSU recommends *that as primary school teachers are non-specialised teachers more resourcing should be allocated to ensure teachers are supported in teaching SESE with an aim to increasing confidence in teaching science.*
The ISSU further recommends *piloting initiatives similar to the CPD programmes of You Be You, this initiative centres around diversity, equity and inclusion. Such programmes are important to overcoming gender biases, as STEM is a field particularly affected by gender segregation.*
The ISSU recommends *that all second-level schools must allow first year students opportunities to trial subjects before making their subject choice.*
The ISSU recommends *a thorough review of ICT in primary schools particularly given the lessons learned during the pandemic.*
The ISSU further recommends *implementing basic computer skills lessons towards the end of students' primary education in preparation for the transition to second-level and the Junior Cycle.*
The ISSU recommends *support should be given to all-girls schools to gain facilities and resources to teach more STEM subjects, notably* engineering, metalwork, woodwork, and technology.
The ISSU recommends *more promotion of newer STEM subjects and the creation of learning materials for these subjects.*
The ISSU recommends *an increase in funding and resources to be given to DEIS schools and schools in disadvantaged areas to facilitate STEM subjects*
The ISSU recommends *that more emphasis be placed on and more funding be given to the development and facilitation of practical STEM subjects in all girls schools.*
The ISSU recommends *the creation of initiatives to encourage and ensure that female students feel welcomed and supported in pursuing practical STEM subjects to Leaving Certificate level in order to ensure that educational equity is established*
The ISSU recommends *the creation of new initiatives to ensure a long term impact. Emphasis should be placed on informing and supporting girls' career/third level education choices.*
The ISSU recommends *more funding to be given to all girls schools in order to start the development of these facilities as well as the partnership of local schools in order to share each other's existing facilities.*
The ISSU strongly recommends *that during the redevelopment of the Senior Cycle and future changes in curriculum to both Junior Cycle and Transition Year by the NCCA, consideration must be given to including a diverse range of named scientists including female scientists and those of colour both on the core curriculum and in exam specifications.*
The ISSU recommends: more support for students in rural areas to access digital learning tools by providing infrastructure for students to purchase technological devices along with improving broadband connections in rural Ireland.
The ISSU recommends *that stimulus materials provided under this strategy be kept stimulating and up to date for students.*
The ISSU recommends *that teachers are supplied with the relevant skill set required for the integration of the Digital Strategy.*
The ISSU recommends *that a wide variety of material is created for all aspects of STEM via digital means and is available to accommodate all types of learners.*

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STEM in Primary Education

1.1) *Ireland had a student to teacher ratio of 15.2 for primary level education in 2018. This was the sixth highest ratio in the EU27 and was above the EU27 average of 13.6.*

- ***The ISSU notes*** *Irish pupils are significantly more likely to be taught by a teacher who is only somewhat confident in teaching science (59% in Ireland compared to 41% across all TIMSS countries)*
- ***The ISSU recommends*** *that as primary school teachers are non-specialised teachers more resourcing should be allocated to ensure teachers are supported in teaching SESE with an aim to increasing confidence in teaching science.*
- ***The ISSU further recommends*** *piloting initiatives similar to the CPD programmes of You Be You, this initiative centres around diversity, equity and inclusion. Such programmes are important to overcoming gender biases, as STEM is a field particularly affected by gender segregation.*

1.2) *The ISSU believes that allowing students to participate in subject 'taster' modules during the transition from primary to second-level education is critical to increasing the numbers of students of all genders studying STEM related subjects.*

- ***The ISSU notes*** *that Junior Cycle Science is not a core mandatory subject like Maths, English and Irish.*
- ***The ISSU notes with concern*** *that despite not being required to study Junior Cycle science before studying science subjects at Senior Cycle, students who have not studied science at Junior Cycle are discouraged from studying scientific subjects at Senior Cycle by teachers and parents.*
- ***The ISSU recommends*** *that all second-level schools must allow first year students opportunities to trial subjects before making their subject choice.*

1.3) *The NCCA has developed 'Information and Communications Technology (ICT) in the Primary School Curriculum, Guidelines for Teachers'[1]. Some specific aims include 'to enable the child to use a range of ICT tools in a relevant curriculum context', furthermore 'the development of ICT skills should be embedded in learning objectives in the Primary School Curriculum'*

- ***The ISSU notes with concern*** *that the use of technology by students is a regular feature of only a minority of primary school mathematics or science lessons.[2]*
- ***The ISSU further notes*** *that this use is primarily used in interactive educational games and activities*
- ***The ISSU recommends*** *a thorough review of ICT in primary schools particularly given the lessons learned during the pandemic.*
- ***The ISSU further recommends*** *implementing basic computer skills lessons towards the end of students' primary education in preparation for the transition to second-level and the Junior Cycle.*

STEM in Post-Primary Education

2.1) *An IWISH study found female students remain underrepresented in STEM subjects, particularly in engineering and technology due to them feeling they would not 'fit in'*

- ***The ISSU notes with concern*** *that many single-sex schools, specifically all-girls schools, do not offer many STEM subjects to students outside of biology, chemistry and physics.*
- ***The ISSU recommends*** *support should be given to all-girls schools to gain facilities and resources to teach more STEM subjects, notably* engineering, metalwork, woodwork, and technology.

2.2) *29,583 students study biology at higher level as a subject for the leaving cert in comparison to 1,696 studying higher level technology, according to Engineers Ireland.*

- ***The ISSU notes*** *there is too much of a focus on STEM subjects such as biology, chemistry and physics which leads to a very close minded view of STEM careers.*
- ***The ISSU further notes*** *the rationale behind this for many students is the lack of learning aids such as exams papers and career guidance when taking subjects such as engineering.*
- ***The ISSU notes with concern*** *the lack of emphasis around taking other STEM subjects such as engineering or metal work in secondary schools.*
- ***The ISSU recommends*** *more promotion of newer STEM subjects and the creation of learning materials for these subjects.*

2.3) *The ISSU believes that the cost of materials needed to facilitate subjects such as technology or graphics may be unachievable for DEIS schools or schools in disadvantaged areas.*

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[1] Information and Communications Technology (ICT) in the Primary School Curriculum - Guidelines for Teachers
[2] https://www.erc.ie/documents/na2009_technical_report.pdf

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- ***The ISSU notes*** *that schools have to consider the cost of facilitating the teaching of the subject while also the technological devices needed.*
- ***The ISSU notes with concern*** *that this leaves many students attending DEIS schools unable to enter a career in STEM if they do not have the financial security to study the subject privately, outside of the main school day.*
- ***The ISSU recommends*** *an increase in funding and resources to be given to DEIS schools and schools in disadvantaged areas to facilitate STEM subjects*

Female Participation, Diversity and Inclusion in STEM

4.1) *In a study$_1$ that was conducted, it was found that the study of practical STEM subjects in secondary school such as Woodwork/Construction Studies, Metalwork/Engineering and Design & Communication Graphics developed STEM related cognitive abilities particularly, Diagrammatic Reasoning.* [3]

- ***The ISSU notes*** *the majority of all girls schools do not offer practical STEM subjects.*
- ***The ISSU notes with concern*** *that not having the opportunity to study practical STEM subjects and develop these key cognitive abilities creates a sexist educational inequity and puts girls at an immediate disadvantage should they choose to study STEM a third level.*
- ***The ISSU recommends*** *that more emphasis be placed on and more funding be given to the development and facilitation of practical STEM subjects in all girls schools.*

4.2) *According to an iWish study, 46% of students believed that gender stereotypes were the main cause of female underrepresentation in STEM careers.*

- ***The ISSU notes that*** *these gender stereotypes exist in second-level education. According to a study$_1$ that was conducted, only 22% of female-identifying Senior Cycle students attending a mixed school actually studied a practical STEM subject. According to the CSO, in the 2019 Leaving Certificate, female-identifying students only made up 11.4% of candidates sitting the Construction Studies, Engineering and Design & Communication Graphics examinations.*
- ***The ISSU notes with concern*** *that in the same study as mentioned above, it was found that 43% of female-identifying students Senior Cycle students attending a mixed school studied a practical STEM subject and later dropped it.*
- ***The ISSU recommends*** *creating time-bound gender targets and other initiatives that would encourage increased uptake and support for female students studying STEM subjects at Leaving Certificate level.The goal of this recommendation is to achieve greater gender equity.*

4.3) *The ISSU believes that existing STEM initiatives have limited reach and sustainability*

- ***The ISSU notes*** *that while there are opportunities and organisations that support and encourage female participation in STEM, they are mainly situated in urban areas, meaning that female students in rural areas have less opportunities this leads to lack of mentoring and career coaching for females in rural areas. Many STEM initiatives are only a once off and only last for a short period of time.*
- ***The ISSU notes with concern*** *that according to an iWish survey, 66% of students believed that a lack of information about STEM careers was a barrier to women pursuing STEM careers. Despite not having access to practical STEM subjects, 45% of students in all girls schools would be interested in a future career in STEM. Of both male and female identifying students who have access to practical STEM subjects, 44% would be interested in a future career in STEM.*
- ***The ISSU recommends*** *giving further support to initiatives like TeenTurn, to ensure a long term impact. Emphasis should be placed on informing and supporting girls' career/third level education choices.*

4.4) *The ISSU believes that developing the facilities to deliver practical STEM subjects in all girls schools may be unachievable.*

- ***The ISSU notes*** *that many all girls schools do not have any existing wood and metal workshops necessary to facilitate practical STEM subjects. The planning and building of these facilities is a very expensive and timely process.*
- ***The ISSU recommends*** *more funding to be given to all girls schools in order to start the development of these facilities as well as the partnership of local schools in order to share each other's existing facilities.*

4.5) *The ISSU believes that discussion of female participation in STEM must also include a discussion of Gender Equality. Young women are significantly less likely than their male peers to pursue careers or education in STEM[4]. This is due to several factors such as discrimination, biases, social norms and expectations, all of which influence the society they live in and the education they receive.*

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[3] *Sexist Subject Stereotypes Suppress the Development of STEM Skills- Camille Ní Shúilleabháin & Clodagh Lehane, BT Young Scientist 2022*
[4] *OECD (2019a). Based on PISA 2018 supplementary results Table II.B1.8.22*

- ***The ISSU notes with concern** that at second-level, only 17% of girls who are top performers in maths and science aspire towards a career in science and engineering compared with 30% of boys in the same high-performing category.*[5]
- ***The ISSU notes** that in 2017, 24.9% of third-level female graduates were in the field of Health and Welfare - where nursing is traditionally a female field. In the same year, only 3.6% & 2.5% of female students graduated from third level programmes in the traditionally masculine fields of 'Engineering, Manufacturing and Construction' and ICT respectively.* [6]
- ***The ISSU further notes** that in 2017, 9.1% of male third-level graduates came from the field of Health and Welfare, while 17.8% and 10.4% of male graduates came from traditionally masculine fields of 'Engineering, Manufacturing and Construction' and ICT respectively.*
- ***The ISSU notes** that as shown in the statistics above it can be reliably inferred that social norms and expectations surrounding STEM negatively impact girls' chances of pursuing STEM in higher education in STEM beyond traditionally female courses such as nursing.*
- ***The ISSU further notes** that this gender imbalance in traditionally more masculine fields of STEM stretches to the highest levels, as since Marie Curie in 1903, only 17 Nobel laureates in the fields of Physics and Chemistry have been female, compared to almost 600 male laureates.*
- ***The ISSU recognises** that due to the historical marginalisation of women in scientific fields, the contributions of pioneering women such as Mary Somerville and Elizabeth Fulhame have been overlooked. STEM curriculums need to become more inclusive of female and non-White scientists as an integral part of the curriculum. If we are to change how society views STEM and encourage young girls to pursue careers in STEM, we must show students that not all mathematicians or scientists are White men.*
- ***The ISSU strongly recommends** that during the redevelopment of the Senior Cycle, and future changes in curriculum to both Junior Cycle and Transition Year, consideration must be given to including a diverse range of named scientists, including female scientists on the core curriculum and in exam specifications.*

Digital Strategy in Education to Support STEM

***5.1)** ESRI research found that 57% of schools reported access to broadband and technology as a barrier to students, particularly in rural and disadvantaged areas.*

- ***The ISSU notes** that STEM resources such as smartfutures.ie are only available online, which means that students must have access to both a computer or tablet and a stable internet connection to avail of them.*
- ***The ISSU recommends** providing* more support for students in rural areas to access digital learning tools by providing infrastructure for students to purchase technological devices, along with the improvement of broadband connections in rural Ireland.

***5.2)** The ISSU believes that without regularly updated material for STEM subjects, students will not engage with the subject or similar resources as they will believe it to be outdated and nugatory.*

- ***The ISSU recommends** that stimulus materials provided under this strategy be kept stimulating and up to date for students.*

***5.3)** The ISSU believes teachers need to be trained and continuously upskilled when teaching these subjects along with this digital strategy.*

- ***The ISSU notes** that STEM subjects and their content is ever changing as there are constant advancements being made in the STEM sector.*
- ***The ISSU recommends** that teachers are supplied with the relevant skill set required for the integration of the Digital Strategy.*

***5.4)** The ISSU believes that digital resources should be catered to all students, specifically kinesthetic learners and students with learning disabilities.*

- ***The ISSU notes** that students with learning disabilities such as dyslexia will find comprehending online resources difficult if they contain long pieces of text or are not in accessible language.*
- ***The ISSU further notes** by 2018, 23% of the Irish student population required SEN support as well as 17,800 with a statement which is issued to students with the most severe needs according to a Department of Education report.*
- ***The ISSU recommends** that a wide variety of material is created for all aspects of STEM via digital means and is available to accommodate all types of learners.*

[5] *OECD (2019a). Based on PISA 2018 supplementary results Table II.B1.8.22*
[6] *CSO Education - Women and Men in Ireland 2019*

Teachers' Union of Ireland (TUI) response to the invitation of the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science to make a written submission as part of the Committee's roundtable discussion on the future of STEM in Irish education.

(March 2023)

Introduction

The TUI would like to thank the Committee for the opportunity to make this submission on the topic of STEM education. The TUI represents teachers, lecturers and staff (21,000+) in Education and Training Boards (ETBs), voluntary secondary schools, Community and Comprehensive (C&C) schools, Youthreach, institutes of technology and technological universities and those working in out of school services.

The TUI would like to start by saying that Ireland rightly recognises the work of peacemakers like Hume, writers like Casey and Wilde, poets like Yeats, artists like Le Brocquy and musicians like U2. However, how many of us speak of Nobel laureates like William Campbell or Ernest Walton? How often do any of us speak of Tyndall, Hamilton, Kelvin?

How often in the last few years have we all had reason to thank scientists, medical experts, mathematicians for their work in public health responses during a pandemic? How many of us really think of places of great international scientific discovery in Ireland including, for example, Birr Observatory? How many of us think about the importance of understanding mathematics and how it influences our everyday banking or insurance needs?

Importance of STEM education in post-primary, further education and higher education

Every subject and programme has intrinsic value. The post-primary curriculum should continue to be broad-based as this best prepares learners for life and active citizenship, and best anticipates an ever-changing society where complex challenges, global and personal, abound. From time to time, certain disciplines may be considered especially important – by governments or employers. While such perceived hierarchies are often transient, we must value STEM education at the same time as valuing all areas of study. From our experience of the last two decades it is likely that up to 60% of students in school today will work in careers that don't currently exist.

Current performance of Ireland internationally

Ireland has a well-respected education system despite historic under-investment but Ireland still performs well on international comparisons. Of course it is important to highlight that international comparisons come with all the provisos associated with trying to measure educational outcomes. It can be noted that Ireland has the highest level of STEM graduates of any member of the EU.

In PISA 2018, performance was assessed in science, maths and reading literacy. Students in Ireland were significantly above the OECD average in all three domains, with performance in reading literacy amongst the highest across OECD and EU countries.

Equally performance by students in Irish schools was strong in PIRLS 2016, with students in Ireland performing very highly in reading achievement and digital literacy.

Second year students in Ireland were amongst the highest performers, in both science and maths, among the over thirty countries who participated in TIMSS 2019.

In terms of international comparators the one notable negative for Ireland is our performance in terms of whether very high-achieving students in Ireland are being sufficiently challenged.

Learner engagement including female participation, diversity and inclusion

Learner engagement with STEM is very high in post-primary, FET and higher education. Schools, colleges of further education and the IoT/TU sector play a key role in this.

It is interesting to note that the Department of Education found that in 2020 90% of male sixth year students took one or more STEM subjects (excluding Maths) compared to 86% of female sixth year students. The gap is considerably wider when we look at the proportion of sixth year students who took two or more STEM subjects (excluding Maths). In that case 58% of male students and only 34% of female students took two or more STEM subjects. Much of the gap is explained by the fact that 83% of female sixth year students took one or more foreign languages in 2020 compared to just 66% of their male peers.

The TUI notes the current uncertainty about the future of the combined Phys/Chem course and would welcome confirmation from the Department of Education that this course, which is popular especially with small schools which do not have enough students to provide two separate courses, will continue into the future.

The high level of engagement is testimony to the fine work done by teachers and lecturers in encouraging curiosity and critical thinking in education. It is also facilitated by the fact that students in Ireland traditionally take approximately seven Leaving Certificate subjects, thereby enabling a broad range of study. It would be a mistake to reduce the range of subjects choices available to students. Indeed the TUI believes that schools should be resourced to provide a greater range of overall subjects and subject levels so that students, especially in small DEIS schools, can have as much choice of subjects and levels as students in large fee-paying schools, within the overall framework of approximately seven subjects for examination purposes. High levels of engagement are also facilitated by the roll-out of new subjects to the Senior Cycle curriculum such as Computer Science. The TUI cautions against too much emphasis being placed on the ability and willingness of the business/science community to support schools and colleges. Whilst very welcome, such support is often conditional on commercial interests being met. It is also often only available to some schools or colleges in some areas. This is not equitable or reliable for all schools and colleges.

Teacher Supply

There is widespread recognition of a teacher supply crisis. Studies by management bodies, teacher unions and State agencies all give evidence of this. For example, a TUI survey of school leaders in October 2022 found that 91% of schools had experienced difficulties in hiring teachers in the previous six months. Problems were reported in almost all subjects but the biggest difficulties were reported in the areas of Maths, Irish, Home Economics, Chemistry and French. Since then we have continued to receive reports of shortages across all areas. The crisis has spread throughout the curriculum. Schools are frequently resorting to pleading with retired teachers to return to teach exam groups because no teacher even applied for a position when it was advertised. Subjects across the entire curricular spectrum, and not just in the STEM area, are at risk of being dropped by schools because no teacher, or only an out of field teacher, can be sourced. The TUI believes that the Department of Education should tabulate the number of schools who cannot offer a subject due to the fact that they could not fill a post and if they decided not to advertise the post as they believed it would basically waste the time of management setting up timetables and then having to change the timetable.

Student numbers in both post-primary and further and higher education are expected to rise significantly in the coming years thereby increasing the need for a supply of qualified and well-paid teachers and lecturers. The TUI has long made clear that the duration, and cost, of initial teacher education discourages students from choosing to enter teaching careers. Precarious employment, especially in tertiary education, makes teaching and lecturing less appealing to potential staff. Large class sizes also impede STEM education. In the case of initial teacher education for post-primary, it is difficult to encourage students to spend up to six years studying to be a teacher. There is a substantial financial cost to such study but also a very large opportunity cost to the student of not having an income for six years.

Investment in the Education System

Irish teachers and lecturers continue to provide a first-class education service to learners of all abilities against the backdrop of significant additional challenges. The findings of the OECD Education At A Glance 2021 report make clear that educators have been carrying out their work in a sector that is chronically under-resourced by international standards. With a range of current and future challenges, an adequately-funded education system must be seen as central to the country's future, and Government must urgently commit to redressing the damage of years of cutbacks and neglect. The key statistic in the report shows that of the countries for which figures are provided, none spent a lower proportion of national wealth on education than Ireland's (3%). At second level, the situation remains particularly dire, with Ireland's spend (1.1%) the lowest of the 36 countries for which figures are provided, trailing unacceptably far behind the OECD and European averages (both 1.9%).

Conclusion

The Irish education system, at all levels, is performing very well in the area of STEM. We can however improve, especially in the context of high-performing students. We started by saying that we need an education system that is funded and equipped to nurture great figures such as Hamilton, Kelvin, Walton and Campbell. However, we also need an education system that can nurture towering figures in music, art, literature, history, geography, languages, business, sport etc. Like the arts and the humanities, the only limit to achievement in STEM in Ireland is our imagination, and of course resourcing in terms of people and funding.

Recommendations

The TUI would like to make the following recommendations to the Committee:

- There needs to be more staff and smaller student-staff ratios in all sectors of the education system.
- Exchequer funding of the education system must be dramatically increased, starting with a gradual move, over three years, upward towards the international average for investment in education as a percentage of GDP.

- Additional targeted teacher allocation should be given to schools so that small schools can provide STEM subjects with small classes and thereby equitably maintain student choice and equality of opportunity. This additional teacher allocation could be provided by way of curricular concession. Curricular concession should also be provided where schools wish to provide new subjects such as Computer Science.
- Additional supports should be given to schools which don't have access to business locally. Equity across the education system is important.
- Additional staffing of guidance services in schools, FE colleges, HE institutions and in the Adult Guidance Service would be helpful.
- The combined Phys/Chem course in Leaving Certificate should continue to exist.
- More progression pathways should be recognised.
- More teacher CPD should be available within school time.
- Society needs to see STEM as important and cease to be proud of being poor at Maths or Science.
- There needs to be restoration of the quantum of middle management posts which existed a decade ago, and also to be adjusted upward to account for the larger number of students in post-primary now.
- The forthcoming TG4 children's channel should broadcast educational and entertaining shows about STEM.
- Society needs to recognise that STEM doesn't just happen in multinational companies. It happens in every hospital laboratory testing patients for cancer, and it happens in food safety centres, and it happens in predicting population needs such as healthcare into the future. It happens in robotics, 3D printing and artificial intelligence used in medicine.
- Schools should be allowed to pay the subject association membership fees of their staff.
- Work should resume as quickly as possible on the revised specifications for Physics, Chemistry and Biology which have been on pause since the Minister's Senior Cycle announcement of March 2022.
- Provide additional support to gifted and talented students.
- Apprenticeships need to be valued by society.

Ends

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2023

2023/067

Submission to Oireachtas Joint Committee Education, Further and Higher Education, Research, Innovation, & Science

THE FUTURE OF STEM IN IRISH EDUCATION

THE HIGHER EDUCATION COLLEGES ASSOCIATION (HECA)

The Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

1. Introduction

The Higher Education Colleges Association (HECA) welcomes the opportunity to make this submission to the Joint Committee of Further and Higher Education, Research, Innovation and Science on the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education. HECA represents the majority of established, mature, privately funded higher education institutions (HEIs)[1], providing QQI validated, flexible, cost effective and focused programmes at levels 6-9 on the NFQ. HECA member HEIs operate predominantly without the benefits of State funding or student support, thereby necessitating the delivery of practical and economically relevant programmes. As members of HECA, these institutions offer a range of STEM subjects, including technology, maths-based programmes, and engineering. These courses contribute significantly to the skills base of both the Irish and global labour markets. Additionally, our member HEIs provide teacher training programmes across all levels, from Early Years to Post-Primary.

2. Executive Summary

In the 21st century, we face rapid technological advancements and societal changes, along with uncertainty over the future of work, the economy, and society. STEM will play a critical role in all our futures and STEM education is vital in preparing students for the future of work and providing individuals with the skills and knowledge necessary to succeed in a wide range of careers and fields in the rapidly changing world. STEM jobs are more in demand every day and expected to grow exponentially over the next few years. The future of STEM in Irish Education needs to be inclusive of all students attending HEIs, both public and private as regards accessibility, progression pathways in higher education, fees and student supports.

3. Developing Future Skills to Support STEM Education

National and international competency frameworks broadly agree on the importance of 21st century skills, which are transferable knowledge and skills that learners need for STEM proficiency. In order to empower students with these skills, it is crucial to enhance the capabilities of educators, as simply depending on established methods is inadequate. Enhancing teacher capacity to teach 21st century skills is crucial for improving student STEM outcomes and developing institutional and teacher capacity through policies, frameworks, and programmes is critical for ensuring sustainable development of students' 21st century skills, according to international evidence (Reimers, 2020).

In Ireland, STEM education is a key focus in various educational policies such as the Action Plan for Education, National Skills Strategy, Arts in Education Charter, National Strategy: Literacy and Numeracy for Learning and Life, Digital Strategy for Schools to 2027, and the STEM Education Policy Statement 2017-2026. The STEM Education Policy Statement identifies actions to be taken in initial teacher education (ITE), including improving the quality of ITE, developing guidelines for STEM education in school placement, and fostering partnerships between ITE, STEM research, and industry. From early childhood to post-primary education, Ireland has a clear pathway for developing 21st century skills through various curricula and frameworks[2] .

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[1] *HECA HEIs: CCT College Dublin, Dorset College, Dublin Business School, Galway Business School, Griffith College, Hibernia College, IICP Education and Training, Irish College of Humanities & Applied Sciences, SQT Training Ltd., Open Training College, Setanta College, St. Nicholas Montessori College Ireland.*

[2] *In the Irish education system, a clear pathway for developing 21st century skills is in place, starting with Aistear, The Early Childhood Curriculum Framework and its themes of Wellbeing, Identity and Belonging, Communicating and Exploring and Thinking. This pathway then moves onto the new*

While institutional and teacher capacity development through policies, frameworks, and programmes is essential, achieving and advancing STEM education goals necessitates enhancing initial teacher education and providing continued professional development opportunities (Reimers, 2020). This is crucial for ensuring that teachers are equipped with the necessary skills and knowledge to effectively teach and promote STEM education. The quality of teaching remains one of the most important factors influencing student learning opportunities (Hattie 2009) and it is crucial to explicitly develop teachers' capacity to understand, embed, and assess learners' future skills as well as recognising the role of teacher training in promoting excellence in digital and STEM education. Thus, schools should create conditions to increase the motivation and engagement of school leadership teams to embed STEM education as a critical component in the culture of each school.

Recommendations to support STEM Education in ITE:

- Explicit teaching of 21st century skills to students
- Provide clear examples of teaching and learning approaches that support 21st century skills development while on school placement.
- Renewed focus on problem and inquiry-based teaching methodologies during ITE training to support 21st century skills development.
- ITE institutions prioritise the development of teachers' understanding, implementation, and assessment of learners' future skills, as the quality of teaching remains one of the most important factors affecting student learning outcomes (Hattie, 2009). To support this goal, provide ongoing learning opportunities, develop guidelines for STEM education during school placement, and establish effective partnerships with STEM research and business and industry.

4. STEM in Primary and Post Primary Education

STEM education relies heavily on technology as one of its fundamental components, which is often considered a neutral tool. However, it is important to recognise that teachers, particularly in primary and post-primary schools, cannot unquestionably use technology to promote learning and accessibility. Regardless of the teaching methodologies and learning environments, the focus should always be on ensuring that students are at the **centre** of the education process and outcomes.

Technology is increasingly playing a significant role in classrooms, reflecting the interactive media children use from an early age. To authentically integrate technology into the classroom, teachers should aim to allow pupils to use **familiar** devices to enhance their learning and provide concrete methods for tracking individual achievements and personalising lessons. Authentic integration of technology can improve student engagement by incorporating kinaesthetic and whole-body learning, which can encourage critical thinking.

STEM education offers multiple benefits for all students, including neurodivergent students, fostering flexibility of thought, multiple manners of communication, neuroplasticity, and creative approaches to assessment. It's important the STEM education of the future has a **hands-on active learning approach**. Not only does this approach encourage critical thinking, independence, and creativity, with real-world applications, it also increases student performance across all course types, levels, and class sizes. Utilising interactive pedagogies for STEM education also enable students to engage on another level with their learning environment, facilitating deeper and more meaningful peer-to-peer learning and communication skills (Mobley & Fisher, 2014). Moreover, children must have active experiences in the world for knowledge

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draft Primary School Curriculum with its key competencies, which include Being an Active Citizen, Being Creative, Being a Digital Learner, Being Mathematical, Communicating and Using Language, Fostering Well Being, and Learning to be a Learner. Post-primary schools also have new frameworks in place for 21st century skill development.

to be acquired [3] and research highlights the positive impact of **school-community links** (Robinson, 2015). STEM is an area that provides many opportunities for primary and post-primary school students to learn about the real-world applications of STEM through the links that exist between schools, higher education institutions, industry, and the wider community.

Importantly, studies (Theobald et al, 2020; Sandrone et al, 2021) have indicated that STEM active learning approaches also reduced achievement gaps in exam scores with a beneficial impact on low-income backgrounds and underrepresented minority students.

As STEM education continues to evolve, integrating it into the education system will become more intertwined with learner development. Therefore, adopting a more student-inclusive **Universal Design Approach** will likely become the norm.

Recommendations to support STEM Education in Schools:

- Provide opportunities, through third-level institutions and other relevant organisations, to engage in activities such as Coder Dojos, EU Code Week, The BT Young Scientist Awards, Discover Primary Science and Math, Maths Week, Science Week, Engineers Week, The LEGO League, The Fís Film Festival and VEX robotics, allow students to experience STEM education as a real-world endeavour.
- Focus on providing targeted training in each school, relative to the size of the school, to promote informed inhouse leadership in STEM education.
- Educators should have access to training that enables them to adapt their teaching methodologies and utilise emerging technologies for active, accessible, hands-on / active learning.
- Ensure that appropriate technological innovations make it into learning spaces, guided by educators who understand how modern technology can affect learning and how to use technology to enhance context and enrich learning experiences for students.
- Support initiatives that promote Universal design for learning

The revision of the Leaving Certificate/Senior Cycle curriculum and assessment needs to:

- ensure that all types of learners are catered for,
- active learning and assessment approaches are integrated for STEM as well as cross curricular,
- embed digital technologies in teaching, learning and assessment.

5. STEM in Tertiary Education

STEM education is vital in preparing students for the future, where they must adapt to changing circumstances and stay up to date with the latest developments in their field. The higher education curriculum must be designed to meet current industry needs and prepare students for technological advancements. By providing students with a solid foundation in STEM education, we can help them succeed in an ever-changing and rapidly evolving world. Higher Education also must also consider the changing nature of learning. Since COVID-19, students have also changed their learning habits, demanding more online and asynchronous learning where the student learns in their own time and in their own way. The digital strategy that underpins this needs to include the regulation of programmes such that new programmes and new modes of delivery can be introduced quickly to respond to rapid changes as well as student/work demands. Students expect high-quality services and the ability to choose the way they learn or consume their teaching, and institutions must meet these expectations to remain relevant. Consequently, this method is more resilient to future disruptions and can transform educational practice in the long term.

[3] *Piaget's theory*

Although higher education offers specialised courses in STEM fields, it's crucial to provide not only advanced degrees and post-graduate courses in these subjects, but also interdisciplinary modules that can be integrated with other areas of study. Microcredentials will play a key role in enabling this type of dual-skilling and will also aid in enhancing the digital literacy of adults as well as lifelong learning and upskilling.

HECA member HEIs are strong supporters and providers of existing programmes such as Springboard+ and Human Capital Initiative (HCI) Pillar 1 which offer upskilling and reskilling opportunities in STEM careers but if we are to level the playing field for underrepresented groups in STEM [4] and address the digital divide, we need to increase the provision, methods and integration of STEM into our tertiary education. With the increasing importance of technology in today's world, it is crucial that everyone has access to the skills and knowledge necessary to thrive in the digital age. By providing STEM education to students from all backgrounds, we can ensure that everyone has an equal opportunity to succeed in the modern world.

Recommendations to Support STEM in Tertiary Education

- Policymakers and educators must prioritise STEM education and invest in resources to support it for students to succeed in the 21st century and beyond.
- To respond to rapid digital and STEM changes, national regulation should be flexible and time-sensitive, enabling both private and public higher education institutions to quickly introduce new programmes, microcredentials, and delivery modes under the digital strategy and STEM needs. This also relates to apprenticeships.
- Expansion of the Springboard/HCI programmes to widen the participation of underrepresented groups/digital divide and upskilling.
- HECA member HEIs should be included in the National Forum for the Enhancement of Teaching and Learning STEM related initiatives.

6. Female Participation, Diversity and Inclusion in STEM

In order to secure the future of STEM, it is also important to provide equitable access to high-calibre STEM education for all students, irrespective of their backgrounds. Studies indicate that students from underprivileged backgrounds are less likely to pursue STEM courses, leading to a lack of diversity in the field, including women and individuals from ethnic minorities.

One of the ways to address this is to both improve and simplify the presentation, awareness and understanding of what STEM is, how it is part of our daily lives and futures and away from the narrative that it is a challenging or inaccessible subject. This should be sustained from primary and secondary education through to tertiary education and beyond. By making STEM accessible and evident to all, the creative process of making things and making them better can be presented as a satisfying experience and achievement. This approach could also support greater female participation, as both genders see the world around them as accessible and available for them to understand and improve.

Recommendations for Female Participation, Diversity and Inclusion in STEM

- National and citizen/student perceptions of the accessibility of STEM education and careers needs to be improved.
- Widening participation in STEM education and careers for underrepresented groups should be actively targeted.

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[4] *Underrepresented groups as noted by Minister Harris include females, socio-economically disadvantaged backgrounds, people of colour, those with disabilities, migrants, and the LGBTQ+ community https://www.gov.ie/en/press-release/18f2e-minister-harris-opens-bright-futures-in-technology-event-at-bt-young-scientist-technology-exhibition/*

7. Digital Strategy to Support STEM.

While a HECA member does have representation on the recently launched *Artificial Intelligence Skills Implementation Group Working Group*, for the most part, the private higher education sector does not have representation on national key drivers and decision making panels with respect to the future of STEM education in Ireland, i.e., *National Skills Council, Regional Fora, Expert Group on Future Skills* etc. It is important to ensure that all key stakeholders in STEM education provision and digital strategy are included in national steering groups to ensure their perspectives and expertise are considered. Excluding any stakeholder, particularly a key one, could potentially hinder progress and result in missed opportunities for collaboration and innovation.

Recommendations for Digital Strategies to Support STEM

- Private higher education representation should be included in national Skills Councils, Regional Fora, and Expert Group on Future Skills/STEM (or STEM-related/Digital Education-related) Working Groups.
- It is essential that the State invest in technology and infrastructure, including broadband, to widen accessibility to STEM and create flexible learning environments to prepare students for future challenges and opportunities.

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An Roinn Breisoideachais agus Ardoideachais, Taighde, Nuálaíochta agus Eolaíochta
Department of Further and Higher Education, Research, Innovation and Science

Joint Committee on Education, Further & Higher Education, Research, Innovation and Science.

Responses to Invitations to Make a Written Submission on the Future of Science, Technology, Engineering and Maths in Irish Education.

Department of Further and Higher Education, Research, Innovation and Science

Item 3: STEM in Tertiary Education

Springboard+ and Human Capital Initiative

Existing programmes to support and encourage STEM in Higher Education include Springboard+ and the Human Capital Initiative.

Springboard+ complements the core State-funded education and training system and provides free and subsidised upskilling and reskilling higher education opportunities at NFQ level 6 to level 9 in areas of identified skills need. Springboard+ 2022 has a strong STEM focus, 58% of courses are in STEM areas; all of these areas demonstrate the responsiveness of the higher education sector to advances in technology and changes in our environment. Over 90% of the courses offered in Springboard+ and are delivered in a blended format, which can make them more accessible.

The *Human Capital Initiative* (HCI) forms a key part of the strategic response to a changing world of work and the challenges the economy will face in the period ahead. With a strong focus on innovation and agility, the programmes being supported will ensure that graduates and the education system as a whole, are in a position to respond positively to the challenges and opportunities ahead.

The HCI consists of 3 main pillars - graduate conversion and specialisation courses, additional places on undergraduate provision, and an innovation and agility fund.

HCI Pillar 1, Graduate Conversion Programmes

Human Capital Initiative Pillar 1 provides for Graduate Conversion Courses in a range of courses, building on the experience from ICT Conversion Courses under Springboard+. HCI Pillar 1, Graduate Conversion Programmes, was launched on 17th June 2020, 68% of HCI Pillar 1 course places in academic year 2022 are in STEM-related areas. Over 70% of courses on the Human Capital Initiative Pillar 1 are delivered in a blended format which can make them more accessible.

The second call for proposals under HCI Pillar 1 was launched on Friday 20 January 2023 with a deadline for submission of proposals for Thursday 23 February 2023, 13.00hrs. In Q2 2023, providers will be notified of the approved courses that will be funded in the academic years 2023/24 and 2024/25. These courses are one year, full time conversion courses at Levels 8 and 9, in areas of identified skills need, building on experience of the ICT Conversion Courses under Springboard+.

Full details on Springboard+ and Human Capital Initiative (HCI) courses, the eligibility criteria and how to apply can be found on the website: www.springboardcourses.ie.

HCI Pillar 2, additional places on undergraduate provision

Human Capital Initiative Pillar 2 provided for additional, incentivised undergraduate places in areas of identified skills needs, predominantly STEM and ICT. Enrolment on courses under the pillar 2 of the Human Capital Initiative took place as part of the CAO process in 2020 and 2021. In 2020 61% of the courses (869 additional places) allocated were in ICT and 246 additional places have been verified by the HEA SRS. In 2021 57% of the courses (752 additional places) allocated were in ICT, and 272 additional places have been verified by the HEA SRS

Under HCI Pillar 2, there are two cohorts of students being funded for up to 4 years. Cohort 1 commenced in 2020/21 and can be funded up to 2023/24 and cohort 2 commenced in 2021/22 and can be funded up to 2024/25.

HCI Pillar 3, Innovation and Agility

Human Capital Initiative Pillar 3, Innovation and Agility aims to ensure that courses in areas of skills needs demonstrate innovative methods of teaching and delivery, which will include flexibility in course provision. HCI Pillar 3 will deliver 24 projects in higher education institutions, 17 of which involve collaborations between institutions. These projects have a strong focus on STEM.

The TU Dublin led Convene project, which is increasing the capacity of higher education to anticipate, understand, and deliver emerging skills needed by enterprise, and provide lifelong learning and upskilling opportunities for all, actively supports Women in STEM. The project has introduced two new initiatives to support and develop enterprise leaders: an Executive Ph.D. for Enterprise-Based Leaders and an MBA in Life Sciences Leadership (starting Sept 2022). Convene and the TU Dublin Graduate School of Business and School of Chemical and Pharmaceutical Sciences have collaborated with the 30% Club to offer two scholarships for successful women applicants to boost gender representation in the Life Sciences sector. The TU Dublin led GROWTHhub project has also validated and launched a PG Cert in Entrepreneurship and Innovation for Women, and held Women entrepreneur seminars.

The rate of technological advances, the impacts of climate change and global health issues are transforming how we live at an incessant rate. Increased provision of high-level ICT places in Higher Education Institutions will continue to contribute to the supply of skilled graduates to the ICT sector.

Item 4: Female Participation, Diversity and Inclusion in STEM

The Government's STEM Education Policy Statement was published in 2017 and targets a 40% increase in the number of females taking STEM subjects for Leaving Certificate, which is critical for driving better participation at third level.

Existing programmes to encourage women into STEM careers include Springboard+ and Human Capital Initiative (HCI) Pillar 1. There is a broad range of courses in STEM related areas.

It is also vital that we ensure that apprenticeships are seen as an option by people across society. Only a very small proportion of apprentices are women, and it is vital that we support greater diversity. In April 2022 Minister Harris announced a new gender-based bursary for apprenticeship employers. The bursary, which is worth €2,666, is available to employers who employ apprentices on any national apprenticeship programme with greater than 80% representation of a single gender.

These initiatives will be supported through wider moves to drive gender equality in the higher education system including through the Athena Swan Charter and the Senior Academic Leadership Initiative (SALI) which is increasing the number of women involved in decision making roles in higher education.

Athena Swan Ireland

Athena Swan is a quality charter mark framework and accreditation scheme established and managed by the UK Equality Challenge Unit (now part of Advance HE) in 2005 that recognises and celebrates good practices in higher education and research institutions towards the advancement of gender equality: representation, progression and success.

The Athena Swan charter was launched in the Republic of Ireland in early 2015.The extension of the charter to Ireland was made possible through funding from the Higher Education Authority (HEA). Engagement with the charter is a key pillar of Ireland's national strategy for gender equality with progress linked to institutional eligibility for funding from Ireland's major research agencies. All of Ireland's universities and institutes of technology and several colleges participate in Athena Swan Ireland. There are currently 112 award holders in Ireland (110 Bronze; 2 Silver). 18 institutions hold awards, including 4 legacy awards. 94 sub-units also hold awards.

This data reflects awards made up to and including the April 2022 assessment round as well as Legacy Award applications from Technological Universities as of December 2022.

The Senior Academic Leadership Initiative (SALI)

SALI was launched by the then Minister for Education and Skills in 2019 following analysis carried out by Ireland's Gender Equality Taskforce in 2018 revealed that 52 per cent of lecturers in higher education were female, but just 27 per cent of professors.

The key objective of the SALI scheme is principally to attract outstanding female applicants both from within the sector currently and internationally to apply for senior academic positions in Irish HEIs. Twenty of these posts were approved and filled in the first SALI cycle in 2020, and in November 2021, the Department for Further and Higher Education, Research, Innovation and Science announced that seven of our institutions have been successful under Cycle 2 of the Senior Academic Leadership Initiative (SALI), securing an additional 10 posts at senior academic level in higher education. This brings the total number of posts awarded under SALI to 30.

The posts awarded span a range of disciplinary areas, from Biochemical Engineering, to Sustainable Geoscience, Intersectional Humanities and Pharmaceutical Engineering. These posts will not only have a significant impact in terms of gender equality, but they will also contribute to wider societal goals through research and education. Further posts under SALI Cycle 2 may be approved from a reserve list in 2022.

The Second HEA National Review of Gender Equality in Irish Higher Education Institutions

On December 12th last the Minister Harris launched the Higher Education Authority's Second National Review of Gender Equality in Irish Higher Education.

The Review was launched on March 15th and was carried out by a six-person Expert Group, chaired by Niamh O'Donoghue, former Secretary General of the Department of Social Protection, and consisted of national and international members with expertise and experience in the area of gender equality. The review was undertaken in consultation with key stakeholders from the higher education sector and relevant civil society organisations.

The review is now complete. The Expert Group has made a number of recommendations under the following headings: national requirements; leadership; organisational culture; teaching and learning, resource and quality assurance; intersectionality; career development; precarity; and data capture, analysis and reporting. Two issues have emerged as key to the advancement of gender equality in higher education: the need to take an intersectional approach when addressing gender inequality; and the impact of precarious employment on career development.

Each of the Expert Group's high-level recommendations to HEIs are accompanied by a set of indicators. The HEA will monitor progress against these on an annual basis, which should be accompanied by the publication of an annual progress report. Areas where progress is deemed to be slow will be supported centrally by the HEA with targeted funding through the Gender Equality Enhancement Fund.

Science Foundation Ireland

SFI's Strategy 'Shaping Our Future 2025' has set an ambitious target of attaining at least 35% women by 2025 as research leaders to ensure a more equal, diverse and inclusive research ecosystem, and to reflect the diversity of Ireland's Higher Education Institutions.

In 2021, 28% of SFI award holders, reflecting both Principal and co-Principal Investigators, were women, while 40% of SFI award team members were women.

The overall percentage of women applicants to SFI funding calls has increased from 17% to 43%, while the percentage of grants awarded to women has increased from 20% to 40% in the same period (between 2011 to 2021). The percentage of grants awarded to women was 34% and 40% in 2020 and 2021 respectively (data to Q3 2021).

The SFI Frontiers for the Future programme was first run in 2019 with 35% of the applicants being women and 45% of grants awarded to women. In 2020, women applicants increased to 40%, with 44% of grants eventually awarded to women. The application success rate for women in the SFI Frontiers for the Future Awards 2020 call was 86%.

Focusing on early-career researchers, the SFI-IRC Pathway programme introduced in 2021, has also proven to be a successful call for women applicants, with 52% of applicants being women and 58% of grants being awarded to women.

SFI also operates a range of programmes and activities which create opportunities for the public to engage with STEM, to raise awareness of STEM and to encourage growth in participation across society. SFI place a particular emphasis on those in society that are less represented.

These projects include the SFI Discover Programme which is run in partnership with the Department of Education. It supports projects that create opportunities for broader participation and engagement of the public with STEM. It also provides opportunities for linkages between STEM and the Arts. The programme enables early support for projects which if proven successful could go on to be scaled up with new partnerships.

SFI's Curious Minds and ESERO Ireland programmes support teachers and schools (primary and post primary), helping to develop the innate curiosity of children through a hands-on, inquiry-based approach to STEM.

The work of SFI in the area of STEM education is informed by and aligned with the Department of Education STEM Education Implementation Plan 2022-2026

The Implementation Plan seeks synergies with education strategies including the new Literacy, Numeracy and Digital Literacy Strategy for early years and schools, ESD to 2030: Second National Strategy on Education for Sustainable Development, Digital Strategy for Schools to 2027 and Creative Youth 2023-2027. The recommendations on Gender Balance in STEM Education (published 2022), which encompass wider recommendations towards greater equity and inclusion, inform actions across this plan.

SFI is a member of the Implementation Advisory Group and accordingly, is an active participant in discussions and actions across all areas of the plan. SFI chaired the Gender Balance in STEM Advisory Group which has informed the plan.

SFI supports across all areas of the Plan and has specific actions under the following pillars:

Nurturing learner engagement and participation:

SFI is conducting a review of STEM careers awareness provisions to inform the development of new measures for working with learners, parents/guardians, teachers, guidance counsellors and school leaders to raise awareness of the diversity of STEM professionals, pathways and careers and challenge stereotypes in STEM.

SFI is exploring enhancing linkages between Early Learning Centres/Schools and the SFI Discover Centres Network nationwide in order to provide access to integrated STEM programmes.

SFI (via Discover) and the Department of Education are supporting the STEM Passport for Inclusion Project, led by Maynooth University, which recognises the experiences of girls from DEIS schools as they achieve micro-credentials in STEM, through mentoring and engagement with STEM content knowledge.

Enhancing practitioner capacity:

SFI provides teacher continuous professional development (CPD) at both primary and post-primary level via its Curious Minds and ESERO Ireland (in partnership with the European Space Agency) programmes. CPD encourages teachers to explore opportunities for cross-curricular learning.

The education and outreach programmes of the SFI Research Centres also provide supports.

Using Evidence to support STEM Education:

The SFI Discover programme partnership with the Department of Education supports projects enhancing STEM awareness, education and careers, and provide opportunities for linkages between STEM and the Arts.

Irish Research Council

The IRC requested applicants to its programmes to provide gender data by the categories ‘male’ and ‘female’, up until 2021. In June 2021, IRC adopted a new classification using the terms ‘woman’, ‘man’, ‘gender non-binary’, ‘other’ and ‘prefer not to say’.

Overall, the breakdown across all new awards made in 2022 is:

Award Name	Women	Men	Prefer not to say	Gender non binary	Other	None
All Programmes	279	231	2	2	4	11

Note: these numbers refer to awardees only and do not include numbers for any staff or postgraduate students that would be funded under Principal Investigator-led (PI-led) awards as they would not have been employed/funded at the time of application. This information becomes available at first reporting period in the following year.

Research and Innovation

Impact 2030: Ireland’s Research and Innovation Strategy, was launched by Minister Harris on the 18th of May 2022, it has a focus placed on increasing the number of female entrepreneurs and researchers and increasing the number of research students from underrepresented groups.

National Gender Equality Dashboard for Higher Education Institutions

Based on published Higher Education Institutional Staff Profiles by Gender from the HEA, this dashboard provides an interactive and comparative visualisation of key gender-disaggregated data from Irish higher education institutions (HEIs). The dashboard offers a valuable baseline (2017-2019) from which progress can be measured, and includes all grades of staff, in Universities, Colleges, and Institutes of Technology.

Data of Interest

ICT Enrolments:

ICT enrolments means all student types and course years, undergraduate and postgraduate.

Gender	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Female	14%	15%	14%	15%	15%	15%	15%	16%
Male	86%	85%	86%	85%	85%	85%	85%	83%
Other	0%	0%	0%	0%	0%	0%	0%	0%
Grand Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

STEM enrolments:

These are all enrolments i.e. all undergraduate and postgraduate students across all years of study.

Field of Study (ISCED)	**2014/2015**	**2015/2016**	**2016/2017**	**2017/2018**	**2018/2019**	**2019/2020**	**2020/2021**	**2021/2022**
Engineering, Manufacturing and Construction	23,440	24,100	24,155	24,830	25,490	26,640	27,880	28,805
Information and Communication Technologies (ICTs)	14,165	14,650	14,830	14,675	14,545	14,700	15,025	15,210
Natural sciences, mathematics and statistics	21,435	21,760	21,950	22,315	22,750	23,225	24,510	25,445
Grand Total	**59,035**	**60,510**	**60,935**	**61,825**	**62,785**	**64,560**	**67,420**	**69,460**

% breakdown of Males and Females for STEM enrolments:

Gender	**2014/2015**	**2015/2016**	**2016/2017**	**2017/2018**	**2018/2019**	**2019/2020**	**2020/2021**	**2021/2022**
Female	29%	29%	30%	31%	32%	32%	33%	35%
Male	71%	71%	70%	69%	68%	68%	67%	65%

Springboard+ 2022:

ICT Skills Conversion (Level 8 + 9)	**Total Places Recommended**	**% of total Springboard+ places**
1 Year Full-time	420	3.6%

2 Years Part-time	789	6.7%
Springboard Part-Time		
Engineering, Manufacturing and Construction (including biopharma and medtech)	2,940	25%
Information and Communication Technologies	2,007	17%
Natural Sciences, Mathematics and Statistics (including data analytics)	628	5.3%

HCI Pillar 1 2022:

In 2022, year 3 of the Pillar 1 programme funding is being provided to create 2,632 conversion course places.

HCI Pillar 1	**Total Places Recommended**	**% of total HCI places**
Engineering, Manufacturing and Construction (including biopharma and medtech)	679	26%
Information and Communication Technologies	1006	38%
Natural Sciences, Mathematics and Statistics (including data analytics)	93	4%

Item 5. Digital Strategy in Education to Support STEM

Following on from Ireland's Economic Recovery Plan and the National Recovery and Resilience Plan, there is a diverse skills policy response in place or underway across the School System, HE and FET in response to digitalisation needs. This response includes:

- Digital Strategy for Schools to 2027;
- STEM Education Policy Statement 2017- 2026;
- Technology 2022 Ireland's Third ICT Action Plan;
- Springboard+ and the Human Capital Initiative (HCI Pillar 1);
- Action Plan for Apprenticeship;
- SOLAS's Skills to Compete and Skills to Advance Initiatives and
- Skillnet Ireland's Programmes.

The Digital Strategy for Schools to 2027 works alongside the Department of Education's STEM Education Policy Statement 2017- 2026 to encourage broader participation and enhance STEM learning for all learners, with a particular focus on increasing participation in STEM by females.

The STEM Education Policy Statement 2017-2026 focusses on the many strengths in STEM education, while providing a roadmap to address the areas for development. The areas of policy development and action in relation to STEM education, as identified in the Policy Statement, span 4 pillars as follows:

- Nurture Learner engagement and participation
- Enhance early years practitioner and teacher capacity
- Support STEM Education Practice
- Use Evidence to support STEM education

Ireland is aiming to increase graduate numbers in STEM, and the proportion of STEM graduates among tertiary graduates has steadily increased, reaching 39.9% in 2020. To support new undergraduate places and courses in high-priority areas, EUR 24 million was provided to tertiary institutions under Pillar 2 of the government's Human Capital Initiative.

The new National Digital Strategy *Harnessing Digital- the Digital Ireland Framework* aims to drive and enable the digital transition across the Irish economy and society. This strategy aims to provide digital skills for all – from school, to further and higher education, to life-long learning, with a target of increasing the share of adults with at least basic digital skills to 80% by 2030 and an ambition to further increase the number of ICT specialists.

Airfield Estate submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science, as part of the Committee's examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education

Executive Summary

Airfield Estate believes that the Future of STEM in Irish Education should incorporate food science into the curriculum, and that "hands-on" experiences be built into this. We have outlined Airfield's current role in STEM education through food, and suggested incorporation of food into the STEM curriculum in Ireland in Primary and Post Primary education below.

About Airfield Estate

As Dublin's Sustainable Food Hub, Airfield Estate is a 38-acre working farm situated in Dundrum, Dublin, and is Ireland's only working urban farm. Thousands of visitors come each year to see the delights of farming from our busy bees, to collecting free range eggs to the vast array of organic horticultural produce and regeneratively farmed meat and milk which is used in our award-winning restaurant and farmers market.

We are passionate about educating our visitors on topics such as farming and food sustainability, and give our visitors the opportunity to learn about sustainable agriculture and food production while here. We run a wide range of education programmes, and work with many schools to allow children to experience 'hands on' a real working farm, and to support their knowledge of food. At Airfield, we believe this is an opportunity that all children should have, not just as a novelty, but as a core part of their education which will serve them for a lifetime.

Airfield is a place of lifelong learning, and thanks to the help of the Teaching Council, we're spearheading Discovery Learning techniques that build knowledge at every level and ability through workshops, discussion and interactive play. We work with early childhood care, primary and secondary schools, as well as third level institutions across Ireland, to offer endless opportunities to find out more about food. Things like seasonality, growing and cooking, embracing sustainability and nature are all covered in our school courses and adapted to the class and their needs. We offer internships and Department of Education summer teacher training courses, and for those who left the classroom some time ago – there are gardening, cookery and craft courses that move in time with the seasons and reflect the work we do on the estate every day.

Some educational programmes and initiatives Airfield Estate offers include:

- Junior Cycle Short Course: Food from the Ground Up – a course in which students produce food and in doing so, link and reinforce learning outcomes from Science, Geography, HE, SPHE and Maths in a practical and hands-on way.

❖ Farmer Time – where our panel of over 90 farmers partner with primary and secondary schools across the country to speak to students online each week about what's happening on the farm while linking it to the STEM curriculum as well as geography, history, business studies, HE and Ag. Science specifications.

❖ Breakfast Clubs with DEIS schools – Children come to the estate, collect eggs and milk from the farm, make butter and then sit and eat the simple, healthy breakfast they have created themselves together with their teachers.

❖ Cooking classes for children and young people – giving them a skill for life while educating them on where their food comes from and sustainable farming.

❖ Beekeeping - ensuring that these vital creatures are preserved and understood for the next generation.

❖ WALK REALability programme – This programme supports school leavers with additional needs to experience working in facilities, farming and horticultural work and builds their confidence to move on to employment or further training.

❖ Through our newly appointed Youth Board, we are supporting the members to become leaders in food sustainability.

❖ Other experiences include egg collecting from our hens, watching the jersey herd being milked, picking fresh seasonal fruit and vegetables, and learning about the rich biodiversity that regenerative and organic farming bring.

Food and STEM: Two sides of the same coin

Food science increases student interest in STEM and highlights for students the important principles of STEM. It brings a real-world application to subjects that otherwise may seem quite abstract and inaccessible to young students. We see food - producing and creating it - as an intrinsic part of STEM, and STEM as an intrinsic part of food. You can't have one without the other.

Notably, Science Foundation Ireland this year are running the "Future Food Systems Challenge" which gives academic research teams a unique opportunity to contribute to Ireland's transition to an environmentally sustainable and climate-neutral economy - demonstrating that food and science are inherently linked.

With this in mind, Airfield Estate will focus on two areas as part of this submission:

1. STEM in Primary Education;
2. STEM in Post-Primary Education;

Airfield Estate recognises that STEM education through the topic of sustainable food production, processing and consumption can and would lead to a deeper learning experience for children within the Irish Education system. Not only would their education be improved, but so too would our public health due to a deeper understanding and experience of seasonal and healthy food production and the importance of food sustainability, potentially reducing obesity in young people (currently 1 in 5 Irish children being overweight or obese).

Our environmental issues around food production and farming would be understood and potentially reduced also, along with our future workforce and economy which would be safeguarded for the future (7.1% of our workforce are currently employed in our Agri-food sector which represents 6% of GNI and 9% of exports in value terms).

STEM in Primary Education

Although Airfield Estate welcomes the separation of STEM and its recognition as a standalone topic in the new Primary Curriculum Framework which was launched in recent weeks, STEM is only given between 3 hours 20 mins and 5 hours per month (depending on the age of the children). This is not enough time to allow for the play and integration techniques the new framework calls for. The topic should be taught through themes like Food, so that children can include skills from science, maths, engineering and technology in a real-world way that applies their knowledge. Giving real world application to these subjects will allow students to retain this information, and carry with them lessons to last a lifetime. When children are given the opportunity to experience something in a 'hand on way', they are more likely to remember it.

Not only will students be given the opportunity to apply their learnings, but by giving students hands-on experience, we can build a healthier population that is more conscious of their environment, knows about food and where it comes from, and is ready to be a part of a future Agri-Food industry in Ireland.

Airfield are of the view that at least 2 hours per week at ALL stages (from junior infants to 6th class) should be allocated in the framework to STEM to allow for the play and integration techniques that are needed in order for children to apply their knowledge in a meaningful way.
Airfield are also of the view that there should be at least 1 visit per term to a food producer or farm so that the practical applications of STEM can be fully experienced.

The educational activities at Airfield Estate demonstrate how hands-on, experiential learning coupled with investigative learning techniques like Discovery Learning can create deep and rich learning experiences for children that result in increased retention of knowledge.
As part of the SFI Curious Minds centres, all Airfield's educational activities are based in STEM and demonstrate the practical application of in-class learning. Students are given the time, and space, to explore STEM concepts using all of their senses, the knowledge of the experts they meet and their own peer knowledge. By experiencing an event, multiple learnings can be made and re-enforced within a short timeframe.

For example, the simple act of watching cows being milked allows the educational guides at Airfield to explore the below in the space of one hour;

- Engineering - how the milking parlour is constructed and the machinery within it;
- Science - the biology of the cow, the chemistry of safe milk testing and storage, the physics of the vacuum in the milking machine;

- Mathematics - around feeding the cows and measurements of their health;
- Technology around milk and cow health monitoring equipment.

Airfield Estate also administers the Farmer Time programme which brings together Farmers and our future consumers through virtual phone calls every 2 weeks during the school year. Students experience the complete farming year and at the same time witness the application of STEM in a real-world, real-time way. This programme also demonstrates how the addition of food education to support STEM learning in our school systems does not necessarily mean that there is a need for increased teacher training (as the farmer is the food expert), a cost implication or additional time away from the classroom.

STEM in Post-Primary Education

At the moment, food is only briefly taught at a surface level through science and HE at Junior Cycle level (neither of which are compulsory for students) and Biology, Chemistry and Agricultural Science at Leaving Cert level (all non-compulsory subjects). This means that students could effectively not learn anything about food or food production throughout their secondary school experience. However, there are opportunities for food to be included in the school curriculum and its teaching to be enhanced within the STEM subjects. There would be no additional cost to the schools as there are teachers already present who could easily include STEM through food education (Biology teachers, HE teachers, Chemistry Teachers, Ag. Science teachers and engineering teachers).

For example, Airfield Estate has developed “Food: From the Ground Up” which is a 100 hour non-examinable short course created around food production with many of the science learning outcomes held within it. It is a unique program that links students, the consumers of the future, with their food in a fun, easy way. By growing, cooking and marketing their own food, students are brought on a food journey that opens them up to a world of understanding around local, national and international food production. The course also encourages the students to meet and interview local food producers, processors and chefs so they can experience a range of jobs and local food production that bring to light the Irish food and hospitality industry.

All educational visits to Airfield for Junior Cycle or Leaving Certificate Biology, despite being focused on the ecology of the site, are all grounded in our sustainable and regenerative food practices. The students can experience, measure and appreciate the increased and diverse level of biodiversity on the estate because of how the plants and animals are managed on the estate.

Our Transition year visitors are immersed in the sustainable food production during their visit here as they are tasked to explore how many people Airfield can feed and what sustainable practices are present on the estate. They use their STEM knowledge to explore our closed loop food waste project, our reed bed water treatment and our PV panels which supply us with energy.

Conclusion

STEM in Irish Education must incorporate food education, and that “hands-on” experiences should be built into this. In our experience offering hands-on STEM education through our various educational programmes at Airfield Estate, this method of teaching has a huge positive effect on learning, and on igniting a passion for STEM subjects among our students.

In order to integrate food education and STEM in Irish Education, we are recommending the following should be implemented:

1. One visit per term to a food producer or farm so that the practical applications of STEM can be experienced, and children’s learning is based in a local context.
2. 2 hours of STEM education per week at ALL stages (from junior infants to 6th class) should be allocated to allow for the play and integration techniques.

We would like to take this opportunity to thank you for allowing us to make a submission on this very important topic.

The Airfield team would be very happy to present our views before the Committee at any stage to give you a better understanding of what we’re working to achieve here on a small scale, but that has the potential to be replicated on a much bigger scale across the country.

We would also like to extend an invitation to the Committee members to come to Airfield Estate to really experience our education programmes. You are welcome to come either as a group or individually - we are only 20 minutes from the Oireachtas via the Luas so very easy to access and a worthwhile visit.

An Chomhairle um Oideachas Gaeltachta & Gaelscolaíochta

Todhchaí na hEolaíochta, na Teicneolaíochta, na hInnealtóireachta agus na Matamaitice (ETIM) in Oideachas na hÉireann

Aighneacht COGG don Chomhchoiste um Oideachas, Breisoideachas agus Ardoideachas, Taighde, Nuálaíocht agus Eolaíocht

Is mian le COGG aighneacht a dhíríonn go sonrach ar Thodhchaí ETIM (STEM) in Oideachas na hÉireann a chur faoi bhráid an Chomhchoiste.

Fáiltíonn COGG roimh an deis a bheith in ann páirt a ghlacadh sa phróiseas, mar a bhaineann sé leis na scoileanna lán-Ghaeilge agus Gaeltachta agus ról na Gaeilge sa chóras oideachais ach go háirithe.

Ról COGG

Bunaíodh an Chomhairle um Oideachas Gaeltachta agus Gaelscolaíochta faoi fhorálacha Alt 31 den Acht Oideachais 1998 le go mbeadh sainstruchtúr ann le freastal a dhéanamh ar riachtanais oideachais na scoileanna Gaeltachta agus na scoileanna lán-Ghaeilge. Tá feidhmeanna maidir le múineadh na Gaeilge i scoileanna eile na tíre ag an gComhairle chomh maith.

Baineann ról na Comhairle leis an mbunoideachas agus leis an iar-bhunoideachas agus tá trí mhór-réimse oibre ann:

- Soláthar acmhainní teagaisc
- Seirbhísí taca
- Taighde

Comhthéacs agus an Staid Reatha

Sa Ráiteas Polasaí um Oideachas ETIM (2017-2026)[1], deimhnítear an fhís

> *go n-aithneofar Éire go hidirnáisiúnta mar áit a gcuireann an caighdeán is airde d'éispearas oideachais ETIM ar fáil d'fhoghlaimeoirí, rud a chothaíonn an fhiosracht, fiosrúchán, réiteach fadhbanna, cruthaitheacht, iompar eiticiúil, muinín agus diongbháilteacht, in éineacht leis an spreagadh den nuálaíocht chomhoibríoch.*

Ina theannta sin, aithníonn an Rialtas go mbainfidh foghlaimeoirí, múinteoirí, scoileanna agus an tsochaí tairbhe as oideachas ETIM fuinniúil agus ardchaighdeáin atá ag feabhsú go leanúnach, scoileanna lán-Ghaeilge agus Gaeltachta san áireamh. Sa ráiteas polasaí tá ceithre cholún a bhaineann le forbairt polasaí agus gníomh agus díreoidh COGG ar na réimsí sin:

- Colún 1. Rannpháirtíocht agus rannpháirteachas an fhoghlaimeora a chothú
- Colún 2. Cur le hinniúlacht an mhúinteora agus an chleachtóra luathbhlianta

[1] Ráiteas Polasaí um Oideachas STEM (2017-2026)

- Colún 3. Tacaíocht a thabhairt do chleachtas oideachais ETIM
- Colún 4. Fianaise a úsáid chun tacú le hoideachas ETIM

Aithnítear go mbíonn scoileanna lán-Ghaeilge agus Gaeltachta (T1) ar aon dul le scoileanna eile maidir leis na ceithre dhisciplín de chuid ETIM (an Eolaíocht, Teicneolaíocht, Innealtóireacht agus Matamaitic). Sa seomra ranga agus i ngort an oideachais trí chéile, déantar gach iarracht na hábhair thuas agus na deiseanna lasmuigh den seomra ranga a chur ar fáil. Dála na n-acmhainní teagaisc agus foghlama i bhfoirm chlóite (téacsleabhair san áireamh), is iad na dúshláin is mó atá (agus a bheidh) le sárú go fóill ná deimhniú go soláthraítear na deiseanna céanna do scoileanna lán-Ghaeilge agus Gaeltachta agus a sholáthraítear do dhaltaí/scoláirí i scoileanna a fheidhmíonn trí mheán an Bhéarla.

Na príomh-mholtaí

(Bunaithe ar na réimsí forbartha thuasluaite sa Ráiteas Polasaí)

Rannpháirtíocht agus rannpháirteachas an fhoghlaimeora a chothú

- Aithnítear an dea-obair agus na forbairtí móra atá curtha i gcrích ag an Aonad um Oideachas Gaeltachta (AOG) agus H2 Learning maidir le tionscadal píolótach an Ríomh-Mhoil Ghaeltachta in ábhar na fisice agus na ceimice. Is tús maith é agus moltar go tréan go leathnófaí amach an clár ag an bpointe seo, agus tuilleadh ábhar a chur ar fáil, más féidir, do scoileanna oileánda agus beaga nach mbeadh d'acmhainn acu raon leathan ábhar a sholáthar.
- Tá ábhair áirithe eile ag leibhéal na hArdteistiméireachta a bheadh ar bheagán éilimh trí mheán na Gaeilge – dá réir sin, bíonn sé deacair dul i ngleic ar an ngnáthbhealach traidisiúnta maidir le soláthar acmhainní teagaisc agus foghlama. Moltar go láidir go ndéanfaí scéim chomhoibríoch a bhunú, trína ndéanfaí píolótú ar ábhar amháin mar thúsphointe, agus meithleacha múinteoirí san ábhar roghnaithe sin a earcú agus a chomhordú, le hacmhainní teagaisc agus foghlama cuí a chruthú agus a chomhroinnt ar shuíomh tiomanta lárnach. Bheadh gá le comhordaitheoir saineolach le tabhairt faoin obair seo mar aon le comhairle agus tacaíocht ó gheallsealbhóirí éagsúla, m.sh. COGG, AOG agus foireann ábhair OIDE. Bheadh gá le maoiniú agus tacaíocht bhreise ionas go bhféadfaí an fhís seo a réadú.
- Tá obair déanta ag COGG ag forbairt acmhainní agus téacsleabhair ETIM, agus tá forbairt chuimsitheach déanta ar an matamaitic (téacsleabhair agus an tionscadal Mol Mata). Cuirtear téacsleabhair ar fáil ach tá tuilleadh oibre le déanamh chun freastal ar na riachtanais a bheidh ag scoileanna amach anseo. Moltar gach iarracht a dhéanamh tacú leis na scoileanna san earnáil seo le cothrom na Féinne a bhaint amach in ETIM.
- Maidir le seirbhísí taca a sholáthar trí mheán na Gaeilge, luaitear go minic easpa foirne le Gaeilge nó easpa buiséid le hacmhainní a fhorbairt i nGaeilge agus le hacmhainní a aistriú go Gaeilge. Tá sé leagtha síos in Alt 7(2)(d) den Acht Oideachais (1998) go bhfuil feidhm reachtúil ag an Aire seirbhísí taca trí Ghaeilge a sholáthar do scoileanna aitheanta, a chuireann teagasc trí Ghaeilge ar fáil, agus d'aon scoil aitheanta eile a iarrann soláthar den sórt sin. Iarrtar go gcuirfear seo i bhfeidhm mar ábhar práinne ionas go mbeidh gach taca ar fáil i nGaeilge ag an am céanna agus atá sé ar fáil i mBéarla.
- Tá gá le níos mó acmhainní ag leibhéal na bunscoile trí mheán na Gaeilge agus ba cheart díriú orthu seo mar thosaíochtaí:
    - Téacsleabhair bhunscoile, acmhainn(í) tacaíochta agus tascleabhair (leabhair oibre) le haghaidh ETIM
    - Acmhainní ar líne le haghaidh ETIM trí mhol acmhainní COGG www.tairseachcogg.ie agus eile
    - Pobail Chleachtais bhunscoile a chruthú le haghaidh ETIM chun múinteoirí a bhfuil suim acu san ábhar a tharraingt le chéile, le dea-chleachtais agus acmhainní a chruthú, agus a roinnt.

- Moltar an tacaíocht chuí a chur ar fáil – acmhainní maoinithe agus foirne – ionas gur féidir comhordaitheoir/oifigeach lánaimseartha a earcú, agus airgeadú a dhéanamh ar an oideachas ETIM trí Ghaeilge. Bheadh cúraimí pleanála, comhordaithe agus straitéisithe ar an té seo maidir le comhpháirtíochtaí a bhunú agus a bhuanú, agus deimhniú go mbeadh an bonneagar cuí in áit le hinbhuanaitheacht na bhforbairtí seo a shlánú. Cinnteoidh an ceapachán seo rannpháirtíocht na scoileanna san earnáil agus cothóidh sé "rannpháirtíocht agus rannpháirteachas an fhoghlaimeora."
- Ní hionann gach scoil mar a bhaineann sé le háiseanna. Beidh an-tábhacht le caighdeán an trealaimh (sna seomraí teicneolaíochta agus eolaíochta) agus an lóistín (seomraí agus áiseanna) sna scoileanna ionas gur féidir gach toradh foghlama a bhaint amach agus gach deis a sholáthar do scoileanna a bheidh rannpháirteach, beag beann ar chomhthéacs nó riachtanais teanga.
- Leagtar béim sa Ráiteas Polasaí um Oideachas ETIM ar rannpháirtíocht agus rannpháirteachas na bhfoghlaimeoirí uile agus tá deiseanna ann níos mó machnaimh agus pleanála a dhéanamh le ETIM a chur i láthair agus i gcleachtais in aonaid speisialta.

Cur le hinniúlacht an mhúinteora agus an chleachtóra luathbhlianta

- Aithnítear an dul chun cinn atá déanta i ndáil le tionscadail áirithe ETIM le linn thréimhse an Pholasaí don Oideachas Gaeltachta go dtí seo. Caithfear tógáil anois ar an tús maith atá déanta ag COGG i gcomhpháirt le Scoilnet agus leis an Aonad um Oideachas Gaeltachta (AOG) ar an Tairseach www.tairseachcogg.ie agus ar na hiarrachtaí go dáta líonra de phobail chleachtais ábharbhunaithe T1 a chur ar bun go comhoibríoch ar bhonn digiteach.
- Aithnítear an soláthar a dhéanann na seirbhísí tacaíochta (SFGM/OIDE) i dtaobh: Fillteáin Dhigiteacha, Ciste Barr Feabhais Scoileanna - Braislí Cruthaitheacha, Mol Mata (a raibh COGG dlúthpháirteach leis), "Éagsúlacht, Comhionannais agus ionchuimsitheacht in ETIM" srl. Meabhraítear an tábhacht atá le scoileanna lán-Ghaeilge agus Gaeltachta a bheith san áireamh nuair a chruthaítear na deiseanna agus na hacmhainní seo.
    - Ar an mbonn sin, moltar go mbunófaí cnuasaigh do scoileanna lán-Ghaeilge agus Gaeltachta mar chuid den *Schools Excellence Fund.*
- Cé go gcuirtear deiseanna ar fáil, ní i gcónaí a sholáthraítear an tseirbhís trí Ghaeilge. Moltar oiliúint níos cuimsithí agus níos fairsinge a chur ar fáil do mhúinteoirí atá ag teagasc trí mheán na Gaeilge i réimsí riachtanacha éagsúla ETIM atá comhthéacs agus teangabhunaithe.
- Go ndéanfaí earcú laistigh de OIDE ar oifigigh/comhairleoirí ETIM lánaimseartha x 2 le hardinniúlacht sa Ghaeilge – duine le cúraimí bunscoile agus duine le cúraimí iar-bhunscoile. Moltar go n-oibreoidís i gcomhpháirt le seirbhísí taca eile, m.sh. COGG, AOG, chun comhairle a fháil maidir leis na bearnaí reatha sa soláthar.
- Is minic a dhéanann scoileanna cinneadh ábhair theicneolaíochta nó ábhair ETIM a cheannach gan triail a bhaint as an ábhar ar dtús. Ba cheart go mbeadh líon mór d'acmhainní crua ar fáil sna hIonaid Oideachais, ionas gur féidir le scoileanna iad a thógáil ar iasacht ar feadh tamaill chun triail a bhaint astu.
- Moltar go soláthrófaí tacaíocht bhreise do cheannairí scoile maidir le bainistiú agus cothabháil oideachas ETIM. Bíonn obair mhór leanúnach i gceist anseo agus ba chóir an t-aitheantas cuí a thabhairt dó seo i leithroinnt na n-uaireanta múinteoireachta.
- Moltar go mbeadh ról an chomhordaitheora ETIM curtha ar fáil: ar bhonn *ex-quota* agus ar comhchéim le ról na gcomhordaitheoirí cláir eile mar gheall ar ualach na hoibre a ghabhann leis na dualgais bhreise sin.

Tacaíocht a thabhairt do chleachtas oideachais ETIM

- Agus forbairtí curaclaim idir lámha, aithníonn COGG na deiseanna a thugtar don eagraíocht a bheith rannpháirteach sna comhairliúcháin.
- Moltar go mbeadh tacaíocht curtha ar fáil do COGG chun treisiú a dhéanamh ar na naisc idir scoileanna agus pobal ghnó na Gaeilge (sa Ghaeltacht agus lasmuigh). Tá an comhoibriú - atá cruthaithe ag *Junior Achievement Ireland* agus Údarás na Gaeltachta do Chlár na gComhlachtaí agus do chlár speisialta Eolaíochta, Teicneolaíochta, Innealtóireachta agus Matamaitice (ETIM), *An Chruinne,* do bhunscoileanna Gaeltachta - ina eiseamláir den dea-chleachtas agus moltar an múnla seo a fhiosrú agus a leanúint.
- Moltar go ndéanfaí leathnú amach ar bhonn níos réigiúnaí ar an togra *Bleaist Eolaíochta*, a bhfuil rath uirthi le blianta anuas sna gaelscoileanna, ionas go bhféadfaí tuilleadh bunscoileanna Gaeltachta a mhealladh ina threo.

Fianaise a úsáid chun tacú le hoideachas ETIM

- Ag aithint na bhféidearthachtaí atá ann tacú le torthaí ETIM an Rialtais a bhaint amach, leanfaidh COGG ag fáiltiú roimh iarratais ó thaighdeoirí aonair nó ó institiúidí le tabhairt faoi thaighde (mar thionscadal taighde fadtréimhseach nó gearrthréimhseach) ar réimsí éagsúla a bhaineann le hoideachas ETIM.
- Cé go bhfuil freastal áirithe déanta ar raon scileanna ETIM go dáta, aithnítear go bhfuil bearnaí ann fós agus tá COGG réidh chun tacú le coláistí tríú leibhéal a bhíonn ag iarraidh cosán forbartha ETIM a leagan amach do mhic léinn a fhoghlaimíonn trí Ghaeilge. Beifear ag súil le deiseanna a sholáthar dóibh siúd a léiríonn suim oideachas lán-Ghaeilge a leanúint ag an tríú leibhéal, trí obair ar bhonn na comhpháirtíochta le hinstitiúidí oideachais ábhartha.
- Go gcuirfí áiteanna faoi leith ar leataobh do mhúinteoirí ar chúrsaí scilbhisithe/uasoiliíúna (Matamaitic/Fisic agus réimsí ábhartha ETIM) a dhéanamh, ionas go gcinnteofaí soláthar cuí do scoileanna lán-Ghaeilge agus Gaeltachta.

Tá aighneacht COGG ar an Straitéis Dhigiteach do Scoileanna 2021 ar fail anseo.

Conclúid

Aithníonn COGG an tábhacht mhór a bhaineann leis an Eolaíocht, Teicneolaíocht, Innealtóireacht agus Matamaitic (ETIM) i saol an lae inniu, agus go deimhin na forbairtí eacnamaíocha, fiontraíochta agus cruthaitheacha a easacraíonn astu. Má tá ról lárnach ag an gcóras oideachais le foghlaimeoirí a ullmhú chun tionchar a imirt ar na féidearthachtaí sin ag tarraingt ar an eolas, na scileanna agus an meon a d'fhorbair an córas oideachais, ba mhaith le COGG a chinntiú go mbeidh na scoileanna Gaeltachta agus lán-Ghaeilge ar comhchéim leis na scoileanna eile sa chóras anois agus sa todhchaí.

D'fháilteodh COGG go mór roimh dheiseanna aon chuid de na moltaí seo thuas a phlé ar mhaithe le soláthar cuí a dhéanamh i ngort an teagaisc agus na foghlama in ETIM do na scoileanna lán-Ghaeilge agus Gaeltachta. Beimid ag súil le bheith rannpháirteach sa phlé agus le bheith ag obair i gcomhpháirt leis na geallsealbhóirí eile amach anseo.

Márta 2023

An Chomhairle um Oideachas Gaeltachta & Gaelscolaíochta

The Future of Science, Technology, Engineering and Mathematics (STEM) in Irish Education

COGG's Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

COGG wishes to make a submission to the Joint Committee, focusing specifically on the Future of STEM in Irish Education.

COGG welcomes the opportunity to take part in the process, as it relates to Irish-medium and Gaeltacht schools and the role of the Irish language in the education system in particular.

The role of COGG

An Chomhairle um Oideachas Gaeltachta agus Gaelscolaíochta was established under the provisions of Section 31 of the Education Act 1998 so as to provide a specialised structure to service the educational needs of Gaeltacht and Irish-medium schools. The Comhairle also has functions relating to the teaching of Irish in other schools across the country.

The role of the Comhairle relates to primary and post-primary education and there are three main areas of work:

- The provision of teaching resources
- Support services
- Research

Context and the Current Situation

The STEM Education Policy Statement (2017-2026)[1], lays out the vision that

> *Ireland will be internationally recognised as providing 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.*

Additionally, the Government recognises that learners, teachers, schools and society will benefit from vigorous, high-standard STEM education that is constantly improving, Irish-medium and Gaeltacht schools included. In the policy statement, there are four pillars that relate to policy development and action and COGG will focus on those areas:

- Pillar 1. Nurture learner engagement and participation
- Pillar 2. Enhance teacher and early years practitioner capacity
- Pillar 3. Support STEM education practice
- Pillar 4. Use evidence to support STEM education

[1] STEM Education Policy Statement (2017-2026)

It is recognised that Irish-medium and Gaeltacht schools (L1) tend to be on a par with other schools in relation to the four disciplines of STEM (Science, Technology, Engineering and Mathematics). In the classroom and in the field of education in general, every effort is made to make the above subjects and opportunities outside the classroom available. As with the printed teaching and learning resources (including textbooks), the biggest challenges yet to be overcome are (and will be) ensuring that the same opportunities are provided to Irish-medium and Gaeltacht schools as are provided to pupils/students in schools operating through English.

Main recommendations

(Based on the above-mentioned areas of development in the Policy Statement)

Nurture learner engagement and participation

- The good work and considerable developments that have been achieved by the Gaeltacht Education Unit (GEU) and H2 Learning in relation to the pilot Gaeltacht E-hub Project in the subjects of physics and chemistry are recognised. This is a great start and it is strongly recommended that the programme be extended at this point, and more subjects made available, if possible, for island schools and small schools which would not have the resources to provide a broad range of subjects.
- There are other subjects at Leaving Certificate level that would not be in high demand through the medium of Irish, and accordingly it is difficult to engage in the usual, traditional manner in relation to the provision of teaching and learning resources. It is strongly recommended that a cooperative scheme be established, through which a single subject could be piloted as a starting point, and teams of teachers in that chosen subject could be recruited and coordinated, to create appropriate teaching and learning resources and to share these on a dedicated central site. An expert coordinator would be required to undertake this work, as well as advice and support from different stakeholders, for example COGG, GEU and OIDE subject staff. Additional funding and support would be required in order to realise this vision.
- COGG has carried out work in developing STEM resources and textbooks, and comprehensive development has been achieved out in mathematics (textbooks and the Mol Mata project). Textbooks are made available, but more work remains to be done to service the needs of schools in the future. It is recommended that every effort be made to support schools in this sector to achieve parity in STEM.
- In relation to providing support services through Irish, the lack of staff with Irish and the lack of a budget for developing Irish-language resources and for translating resources to Irish are frequently mentioned. It is set out in section 7(2)(d) of the Education Act (1998) that the Minister has a statutory function to provide support services through Irish to recognised schools, which provide Irish-medium education, and to any other recognised school that asks for any such provision. It is asked that this be implemented as a matter of urgency so that every support be available in Irish at the same time as it is available in English.
- More Irish-language resources are required at primary school level and these should be prioritised:
  - Primary school textbooks, support resource(s) and taskbooks (workbooks) for STEM
  - Online resources for STEM through COGG's resource hub www.tairseachcogg.ie and more
  - The establishment of primary school Communities of Practice for STEM to gather together teachers with an interest in the subject, to create and share best practice and resources.
  - It is recommended that appropriate support be made available - funding and staff resources - so that a full-time coordinator/officer can be recruited and STEM education through Irish can be financed. This person would have planning, coordination and strategic duties in terms of establishing and perpetuating partnerships, and ensuring that the appropriate infrastructure be in place to ensure the sustainability of these developments. This

appointment will ensure the participation of schools in the sector and it will nurture "learner engagement and participation."
    - All schools are not equal in relation to resources. The standard of equipment (in technology and science rooms) and accommodation (rooms and facilities) will be highly important in schools, so that every learning outcome can be achieved and to give schools every opportunity to participate, regardless of background or language requirements.
    - In the STEM Education Policy Statement, the engagement and participation of all learners is emphasised and there are opportunities for further consideration and planning in order to bring STEM to specialised units and put it into practice there.

Enhance teacher and early years practitioner capacity

- The progress that has been made to date in relation to certain STEM projects during the period of the Policy for Gaeltacht Education is recognised. The good start made by COGG in partnership with Scoilnet and with the Gaeltacht Education Unit (GEU) on An Tairseach www.tairseachcogg.ie and the efforts to date to cooperatively set up a network of L1 subject-based digital communities of practice must now be built upon.
- The contribution of support services (An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí/OIDE) is recognised in relation to: Digital Folders, School Excellence Fund - Creative Clusters, Mol Mata (in which COGG played a key role), "Diversity, Equality and Inclusivity in STEM" etc. The importance of Irish-medium and Gaeltacht schools being taken into consideration is recalled when these opportunities and resources are being created.
    - On that basis, it is recommended that collections be built for Irish-medium and Gaeltacht schools as part of the Schools Excellence Fund.
- Although opportunities are made available, the service is not always provided through Irish. It is recommended that more comprehensive and broader training be made available to teachers who teach through Irish in different essential fields of STEM which are context- and language-based.
- That two full-time STEM advisors/officers with a high level of competency in the Irish language should be recruited from within OIDE - one with responsibility for primary schools and one with responsibility for post-primary schools. It is recommended that they would work in partnership with other support services, e.g. COGG, GEU, to receive advice on the current gaps in supply.
- Schools often decide to buy technological materials or STEM materials without testing the material first. There should be a large number of material resources available in Education Centres, so that schools can borrow them for a period to test them out.
- It is recommended that additional support be provided to school leaders in relation to managing and maintaining STEM education. This involves significant, continuous work, and this should be appropriately recognised in the allocation of teaching hours.
- It is recommended that the role of STEM coordinator be made available: on an *ex-quota* basis and on a par with the role of the other programme coordinators due to the workload that goes with those additional duties.

Support STEM education practice

- COGG recognises the opportunities given to the organisation to be part of consultations while curriculum development is ongoing.
- It is recommended that support be made available to COGG in order to strengthen the links between schools and the Irish-speaking business community (both within the Gaeltacht and

outside it). The cooperation - which Junior Achievement Ireland and Údarás na Gaeltachta have built for the Companies Programme and for the special Science, Technology, Engineering and Mathematics (STEM) programme for Gaeltacht primary schools, *An Chruinne* - is an exemplar of best practice and it is recommended that this model be explored and followed.
- It is recommended that the Science Blast initiative, which has been highly successful over the past few years in *gaelscoileanna*, be broadened out on a more regional basis, so that more Gaeltacht primary schools may find it an appealing option.

Use evidence to support STEM education

- Identifying possibilities to support the government's STEM outcomes, COGG will continue to welcome applications from individual researchers or from institutions to undertake research (as a long-term or short-term research project) in different fields relating to STEM education.
- Although to date a range of STEM skills has been addressed, it is recognised that gaps still exist and COGG is ready to support third level colleges who wish to lay out a STEM pathway for students learning through Irish. It is hoped that opportunities can be provided for those who express interest in continuing Irish-medium education at third level, through working in partnership with relevant educational institutions.
- That specific places be set aside for teachers on upskilling courses (Mathematics/Physics and relevant fields of STEM), so as to ensure appropriate supply for Irish-medium and Gaeltacht schools.

COGG's submission on the Digital Strategy for Schools 2021 is available here.

Conclusion

COGG recognises the huge importance of Science, Technology, Engineering and Mathematics (STEM) in today's world, and indeed the economic, entrepreneurial and creative developments that arise from them. If the education system has a central role in preparing learners to exert an influence on those possibilities, drawing on the knowledge, skills and outlook developed by the education system, COGG would like to ensure that Gaeltacht and Irish-medium schools are on an equal footing with the other schools in the system both now and in the future.

COGG would greatly welcome opportunities to discuss any of the above recommendations in order to facilitate appropriate provision in the field of teaching and learning in STEM for Irish-medium and Gaeltacht schools. We will look forward to taking part in the discussion and to working in partnership with other stakeholders in the future.

March 2023

Submission to Joint Committee on Education, Further and Higher Education, Research, Innovation and Science - Examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

March 2023

Background

Established in 2013, AMBER is the Science Foundation Ireland (SFI) Research Centre for Advanced Materials and BioEngineering Research hosted by Trinity College, University of Dublin, with researchers in 8 additional partner institution around Ireland: RCSI, UCC, Tyndall, DCU, University of Galway, University of Limerick, TUS and UCD.

The AMBER mission is 'to partner with our member companies to deliver world-class materials innovations and translate these into impacts for economic, environmental, health and societal impacts, providing solutions through collaborative research'

AMBER Centre's strategy reflects the three main pillars:

I. World-class materials innovation resulting from the excellence of our research which underpins everything we do,
II. Partnership and engagement with industry not only on collaborative research, but also to contribute to the ethos of the centre in terms of governance & strategy, emerging research challenges and researcher development, and
III. Delivering tangible and meaningful impacts with a focus on ensuring efficient translation of our research for economic, environmental, health and societal impacts.

We are at the forefront of driving advances in materials science and bioengineering and translating research excellence into new discoveries and devices. Our research develops technology to address industrial and global challenges from novel data processing and memory applications, energy storage and energy-efficient devices, regenerative medicine, and drug delivery systems through to plastics sustainability and supporting key national targets such as our zero-carbon 2050 target.

AMBER delivers a unique, integrated capability for materials research to accelerate innovation:

- Brings together Irelands leading researchers across nine higher education institutions
- Provides access to advanced facilities
- Provides a gateway to significant European funding
- Has a team of professional supports to scope, build, and ensure completion of projects to the highest standards, with IP and knowledge transfer capability.

Introduction

AMBER as a world class scientific research centre relies on STEM educated individuals to conduct the highest quality materials science and engineering research. We believe that excellent, relevant and up to date Primary & Secondary level STEM education is a vital foundation for the development of current and future materials scientists, engineers and researchers. Ireland has had success in developing a highly educated populace through policy and its delivery at primary, secondary and tertiary levels. However there remains shortages of highly educated STEM school leavers for industry and academia. There also remains a lack of gender diversity with engineering subjects in particular remaining male dominated. Gender balance is manifest in senior industry and university positions.

Ireland has a technology-based manufacturing economy with materials science and engineering at its heart. To maintain our international success and our economy we must improve STEM education, its uptake, its quality and its diversity. It is also imperative to adapt our STEM education to ensure our preparedness as a society for future developments. As the world enters an era where the elements of society and industry must be sustainable, our education must reflect a need for all its citizens to embrace change and to provide STEM trained school leavers and graduates the expertise to drive our economy forward whilst protecting the planet.

Primary & Secondary Level STEM Education

Resourcing of STEM Education

Industry and Education have engaged in mapping out requirements for future literacy in STEM subject areas including availability of teachers within subject areas, but this is being done on a piecemeal basis. For example, the recent University of Galway Report 'Capacity for, access to, and participation in computer science education in Ireland'[1] commissioned with the support of Google found that in the area of computer science only 16% of schools are offering the subject to senior cycle pupils and the majority of teachers are giving classes, without Teaching Council accreditation to do so. Lead Author of this report Dr Cornelia Connolly, said the findings showed a significant volume of work was needed to ensure that all students had the opportunity to develop essential computer and coding skills, subjects that needed to be viewed as a "foundational competence for all" and that computing education be

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[1] Connolly, Cornelia, & Kirwan, Colette. (2023). Capacity for, access to, and participation in computer science education in Ireland. Galway, Ireland: University of Galway, https://doi.org/10.13025/bccm-2c38

introduced at an earlier age so that students' technical use and understanding correspond with their high level of access to phones and smart technology.

The findings of this Report are an example of the primary and secondary level education system being ill equipped to meet current and future standards in the delivery of fundamental STEM education. SOLAS' Skills and Labour Market Research Unit (SLMRU) as part of its remit to 'provide a data gathering, analytical and research resource to identify skills needs and support the work of the National Skills Council' should be tasked with reporting on STEM, mapping future input needs as regards workforce and education and reviewing on a 5-year basis and in conjunction with IMPACT 2030 targets.

Provision of STEM Education

There currently exists a plethora of optional and additional CPD courses for educators in primary and secondary level education including some of which the AMBER Centre itself has devised and engaged with. This includes a suite of 6 dedicated lesson plans and resources for teachers for ages 4 through to transition year. This resource[2] was developed by AMBER with the aim of improving teachers and their students' content knowledge of material science, understanding of materials science and society relationships, build awareness of materials science and STEM careers and develop students' sense of science identity (being a scientist) facilitating the teaching of science with other subject areas in an integrated manner.

The programmes integrate other value learning pillars focusing on integration of science lessons with literacy, drama, and design and make, developing children's skills in working scientifically, while also meeting literacy and drama objectives. The modules provide teachers with a framework to build a narrative with young learners, with the express objective of developing oral language skills, cooperation, art, design, and STEM learning. Our resources are developed with and for teachers and teacher educators, to ensure they are age appropriate, based on sound pedagogical practice.

Examples of AMBER's engagement and outreach to Primary level school children and educators:

- Primary resources developed including Materials Now and NanoWOW2![3]
    - The NanoWOW! Programme launched in 2014 and was developed for children between ages 10-12 years old, but it is also suitable for older and younger children.
    - NanoWOW! includes short educational videos hosted by AMBER scientists to introduce the properties of materials, the concepts of scale and surface area, exploration of graphene one of the first nanomaterials to be found (and one that is inside a pencil!), discussion of where nanoscience could take us in the future, and how we are using nature to inspire new nanomaterials to solve common problems.
    - Each lesson has a combination of downloadable resources which include background information for parents and teachers, and details of experiments and learning activities for children.
- AMBER collaborated with Education Support Centres across the country and STEAM in Junior Cycle throughout February and March 2022 to deliver 18 professional development workshops for over 200 primary and post primary teachers. These workshops were based on the content

[2] https://ambercentre.ie/engage/schools/overview/
[3] https://www.youtube.com/watch?v=CGn1mFwXXvo

from our AMBER spiral learning programme. AMBER again participated in 2023 with the STEAM project.[4] A focus for us has been sustainability with materials developed on the circular economy and plastics and helping students and teachers meet the needs of the 'Education for Sustainability Programme'.

- Primary online hands-on materials science workshops were delivered to over 750 primary school students in May and June of 2022. Materials for experiments were posted out to schools in advance of the workshops. DEIS and rural schools were given priority for places on this programme.
- Amy Fahy, AMBER's Training and Outreach Manager presented a paper titled 'Leadership in STEM,' at the International Academy of Management Conference Presentation, Seattle, August 2022. This paper explores the perceptions of Irish primary school principals on leadership in STEM, and highlights the importance of specialist teacher instruction, i.e., school-scientist collaborations.

The above initiatives have served to engage greater and more diverse and disadvantaged primary and secondary level students and educators. However, this piece meal basis of STEM engagement and CPD for educators should be prioritized by the Department of Education in Curriculum. Teachers engaging in STEM education should be adequately resourced, prepared, certified and targets for teacher recruitment should include the prioritization of STEM qualifications. The Department of Education should as a first step ensure STEM has a structured place in both primary and secondary level curriculum and that subjects such as sustainability are properly treated within STEM programme. STEM programmes should be delivered with consistent quality across the school network. Secondly engagement with Boards of Management to ensure that schools are resourcing teaching staff and infrastructure to facilitate STEM teaching and that where feasible local schools are sharing resources and infrastructure to offer subjects to all students in a catchment area. Historically it was not uncommon for schools in Local Authority Areas to link up to provide a physics or chemistry class for example to students from various schools within one school that has labs and accredited staff to teach.

Third Level STEM & Workforce Engagement

Supporting & Retaining Research Talent

PhD researchers currently engaged in STEM subjects are the future of teaching and the various hi-tech industries in Ireland. They are our future industry leaders and the vital element in maintaining and developing Ireland's technological economy. Identifying, harnessing and supporting this talent source now can only seek to future proof Ireland in its ambitions to continue to be a world class leader in research, development and innovation and be an attractive location and talent pool for companies

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[4] 'The vision of STE(A)M in Junior Cycle is to "Provide Junior Cycle teachers with rich STE(A)M professional learning experiences in keeping with national and international best standards, which will allow for interdisciplinary responses to societal challenges in subject specific and cross curricular contexts".'
https://www.jct.ie/steAm/steAm

seeking to engage in such industries. However, without adequate supports and funding, this vital supply of talent into the future is at imminent risk of drying up.

As AMBER and many other parties have identified in recent PhD support consultations there is a barrier to entry into STEM at third level currently. Barriers exist in the form of Economic viability and affordability. The current stipend of €19K does not provide a liveable income for students with the current cost of living. This is particularly true for students studying away from home including non-Irish students and students coming from disadvantaged backgrounds. This limits numbers applying for studentships particularly affecting our ability to attract good students from abroad. Student stipends are not competitive against other countries. By way of comparison, in Germany, the average stipend is €24,500, in France €27,000 and in the Netherlands €38,400.

The chronic lack of funding also results in PhD students being left with no option other than to engage in additional out of hours part-time work in other sectors which does not contribute to their studies. This inevitably entails out of hours and weekend work on top of existing hours committed to PhD work and study which can lead to fatigue. If this does not lead to burn out it can impact upon both the quality and duration of their research. The relatively low numbers of PhD opportunities mean that students can be isolated from the support of their peers. These issues have a demotivating effect leading to higher dropout rates.

Major investment in both the numbers and quality of PhD research is urgently required. Per capita we educate less PhD students than our competitors such as the UK, US, Germany, Netherlands, Asian nations etc. and numbers of PhD registrations have dropped considerably in the last 10 years. Research and funding within STEM should also be broad and not solely reliant or linked to industry or competitive grant funding. Indeed, the recently announced Spanish pilot of flexible open-ended funding for researchers[5] which will provide researchers with stable funding for four years to explore new ideas and build capacity, without being tied to specific projects. This provides an opportunity for researchers to explore new ideas without the time constraints of applying for or seeking national or EU grants, which can only serve to improve quality of research and science and compliment traditional funding models.

Industry & Workplace Engagement

Continuing and ongoing engagement with industries and workplaces within the STEM sector is needed whilst developing and monitoring STEM education and resourcing. It must be acknowledged that whilst reviews of PhD funding are ongoing, research centres such as AMBER are essentially employers (and a significant one) of the STEM workforce, be they post-doctoral researchers, PhDs, investigators or other. The opportunity to contribute to this roundtable should be a first step for ongoing engagement between research centres such as AMBER and the Oireachtas. As a research Centre AMBER is uniquely positioned at the coal face of third level STEM education and the intersection of industry. It is the aim of AMBER and research centres who are dealing in real time with the deficit in personnel qualified in STEM nationally, to contribute to solutions to futureproof Ireland’s STEM education.

Conclusion

[5] https://sciencebusiness.net/news/International-news/spain-pilot-flexible-open-ended-funding-researchers

Steps must be taken to safeguard the future of STEM as a significant industry in Ireland, employer and contributor to the national exchequer. Education requirements need to be addressed to meet demands for highly qualified school and college leavers and the evolving needs of students to meet expectations in areas such as sustainability. Mapping exercises of teaching resources and future workforce are greatly needed and should be conducted regularly in line with IMPACT 2030 and to reflect the ever-changing technology and science landscape. With adequate data from mapping and forecasting the focus should be investment to ensure a resilient workforce, which can adapt to changing market needs. Finally, the prioritization of STEM education as part of the national curriculum will ensure that research and innovation is facilitated to focus of finding solutions for the benefit of people, planet and prosperity.

Submission by Prof. Michael Morris AMBER Director, MORRISM2@tcd.ie and Amy Sweetman AMBER Communications & Public Affairs Manager sweetmam@tcd.ie

2023/112

Re: Expert Group on Future Skills Needs submission to Joint Committee on Education, Further and Higher Education, Research, Innovation and Science- The Future of Science, Technology, Engineering and Mathematics (STEM) in Irish Education

To whom it may concern
The Expert Group on Future Skills Needs has been requested to make a submission to the Joint Oireachtas Committee on Education, Further and Higher Education, Research, Innovation and Science, as it undertakes an examination of the future of Science, Technology, Engineering and Mathematics (STEM) in Irish education.

The EGFSN is the independent body established in 1997, which is tasked with advising the Government on the current and future skills needs of the Irish economy. The Group, which undertakes research on medium to long term skills needs at sectoral and occupational level, seeks to inform and support the delivery of broader economic and social objectives.

1. In recent years the Group's research has sought to address the key trends and policy objectives set for the Irish economy,[1] including:
    - The spread of digital transformation across all sectors of the Irish economy, as reflected in *Harnessing Digital- The Digital Ireland Framework* and *AI: Here for Good;*
    - The need to accelerate Ireland's shift to a zero-carbon economy, in particular through the development of offshore, onshore and solar energy capacity, as identified in the *Climate Action Plan;*
    - The need to drive the performance of our SME sector, to advance Ireland's status as an innovative knowledge economy, and further expand and diversify Ireland's international trade and investment, as prioritised by *Impact 2030: Ireland's Research and Innovation Strategy* and *Trade and Investment Strategy 2022-2026: Value for Ireland, Values for the World;* and
    - The pressing need to address Ireland's housing and infrastructural requirements, as well as the enhancement of energy efficiency across the built environment, as set out in *Housing for All* and the *National Development Plan 2021-2030*

2. As the EGFSN's research has borne out, STEM skillsets will be central to addressing these ambitions. What will differ, however, is the scale of the demand for these skillsets compared with recent decades, as well as the commonality of the demand across most advanced economies. The pace of change associated with the digital and green transitions is more rapid than that previously experienced, and this pace has only been accelerated by the impact of the Covid-19 pandemic, as well as the scale and urgency of the ambitions set for Climate Action globally.

3. As well as the key role to be played by STEM RD&I skills in addressing some of society's key grand challenges, the international environment for trade and investment has also become more competitive as, underpinned by technological advances, a more sophisticated consumer base has

[1] More detail is available in the reports listed, all of which are available on the Expert Group on Future Skills Needs website (www.egfsn.ie): *AI Skills- A Preliminary Assessment of the Skills Needed for the Deployment, Management and Regulation of Artificial Intelligence (2022); Skills for Zero Carbon- The Demand for Renewable Energy, Residential Retrofit and Electric Vehicle Deployment Skills to 2030* (2021); *Labour Demand Estimates for Ireland's National Housing Targets, 2021-2030* (2021); *Leading the Way- Investing in Management Development for SME Productivity and Growth* (2020); *Building Future Skills- The Demand for Skills in Ireland's Built Environment Sector to 2030* (2020); *Together for Design- Digital, Product and Strategic Design Skills of the Future (*2020); *Forecasting the Demand for High Level ICT Skills in Ireland, 2017-2022* (2019); *Digital Transformation- Assessing the Impact of Digitalisation on Ireland's Workforce* (2018); *Addressing the Skills Needs Arising from the Potential Trade Implications of Brexit* (2018)

emerged internationally. This demands greater product and service personalisation, which in turn places an emphasis on agile product and service innovation, in order to unlock and retain market opportunities through the transformation of research into commercially viable products and services aligned with user needs.

4. The EGFSN welcomes the recent STEM second level curricular reforms, which have sought to reflect the rapid evolution of STEM related roles, as well as stimulate interest in and provide progression pathways into related tertiary provision. While policy has long recognised the importance of fostering a pipeline of new entrants into STEM roles- most recently reflected in the *STEM Education Policy Statement, 2017-2026*, Science Foundation Ireland's *Smart Futures* campaign, and the Digital Strategy for Schools- the medium to long term demands across technology, climate action, life sciences and Medtech, the built environment and research and innovation will require a step change in Ireland's efforts to attract, develop and continuously refresh its domestic pipeline of STEM talent.

5. In many respects Ireland's traditional shortage of STEM professionals has been a reflection of our success in fostering indigenous enterprise and in attracting, retaining and stimulating further foreign direct investment in STEM related sectors- leading ultimately to a higher demand for skills. In order to fully address the skills needs of our enterprise base, concerted efforts to boost the quantity and quality of our domestic education and training output have been complemented since the 1990s by the establishment of Ireland as a centre for highly skilled international talent.

6. While the attraction of overseas talent will continue to play a critical role in supporting delivery of our economic and social ambitions, the commonality of demands across advanced economies- as reflected, for example, in the EU's Green Deal and Digital Decade- suggests more acute competition for internationally mobile talent going forward, including for Irish workers. Ensuring the security of our pool of STEM talent in this more competitive environment will require an intensification of our efforts to boost our domestic pipeline of STEM skills. This need is most acute in ICT occupations, of which only 66% were Irish nationals in 2021. This compares to 82% for Science and Engineering Occupations, and 90% for construction occupations.

7. Expansion of the domestic pool of STEM professionals will rely to a significant extent on the more effective channelling of students towards programmes, and ultimately employment, in areas of identified skills needs and the addressing of barriers to STEM course and career choices. A skills identification and intelligence system, which can provide sufficiently granular information to effectively inform and maintain the relevance of education and training in such a fast-changing environment, will be central to this ambition.

8. This will require the development of a properly resourced and informed career guidance system and pool of guidance professionals, at secondary and tertiary level, which is more attuned to labour market trends, emerging and evolving career opportunities, and the variety of pathways into associated STEM careers. The targeting of parents, a key formative influence on career choices, will also be important. A key role will also need to be played by enterprise, and specifically its closer engagement with the education and training system at all levels, in order to raise awareness around career opportunities within STEM fields, as well as to help inform course content and facilitate reskilling and upskilling in a context of rapidly evolving skills requirements.

9. This last point is a critical one in this discussion. Expanding the pipeline of initial entrants into STEM professions will need to be accompanied by a robust approach to the regular upskilling of the existing STEM workforce across Further Education and Training and Higher Education, in order to ensure it keeps pace with technological, environmental and scientific trends.

10. This is already a key priority of Ireland's approach to lifelong learning, which is extensively supported through the either free or heavily subsidised programmes funded through the National Training Fund. These include Springboard+, the Human Capital Initiative, Skillnet Ireland's

enterprise led training networks, and a range of programmes across the Education and Training Board network. The new industry consortia led apprenticeships, which are now offered across STEM disciplines including Biopharma, Engineering, and ICT, are also offering reskilling pathways for those transitioning from other job roles or sectors, as well as graduates from initial education.

11. Addressing the gender imbalance within STEM roles- a deficit recognised in the *STEM Education Policy Statement*- will also be critical to meeting the demand for STEM professionals going forward. This gender imbalance is of course not unique to Ireland. But domestically it is impacted by differences in subject choices at school level- a reflection of longstanding subject segregation between girls' and boys' secondary schools. At a time when tertiary study and ultimately career options are being formed, this limits horizons around potential career pathways and ultimately the pipeline into relevant education and training programmes.

12. Again, female participation levels vary by the branch of STEM- 33% of those in Science and Engineering occupations were female in 2021; this was highest for chemical, biological and physical scientists (50%), followed by 39% for Science and Engineering technicians, and 32% for Production, Design and QC Engineers. In the Construction professions, including civil engineering, the share of females is roughly 20%. In terms of ICT occupations, 24% of the workforce was female in 2021; 26% shares were recorded for ICT Specialists and Project Managers and IT Technicians, and 17% for Programmers and software developers. This is also reflected in the breakdown of recipients of employment permits for high level ICT roles, with males accounting for between 73% and 77% of permits over the period 2019-2023.

13. At a time when digital technologies are becoming all pervasive and have the potential to impact on so many aspects of our lives, it is important that the perspectives that are brought to bear on the design and deployment of high-level ICT systems are representative of the population as a whole. This is a consideration which should not solely be confined to the issue of gender imbalance, but also broader diversity considerations within ICT roles.

14. Detailed below are some of the key perspectives relating to STEM skillsets, as reflected in EGFSN studies on digital transformation, climate action and the built environment in recent years. In the coming months the EGFSN will also be publishing a study on the future demand for skills within Ireland's critically important Biopharma sector, which it will be happy to share with the Committee on publication. This study has sought to address the implications of major step changes across the pharma and biopharma sector in recent years: the rapid adoption of technology such AI, additive manufacturing, automation and other Industry 5.0 technologies.

Digital Transformation and High-Level ICT Skills

15. The EGFSN has addressed the issue of digital transformation, and its implications for the demand for High Level ICT or Technology skills (i.e. the skills required to design, build, implement and maintain the integrity of high level ICT systems) in a number of reports since 2018: 2018's *Digital Transformation- Assessing the Impact of Digitalisation on Ireland's Workforce;* 2019's *Forecasting the Future Demand for High Level ICT Skills in Ireland, 2017-2022;* and 2022's *AI Skills: a Preliminary Assessment of the Skills needed for the deployment, management and regulation of Artificial Intelligence*.

16. These skills, in areas including Artificial Intelligence, Data Analytics, the Internet of Things, Cloud Computing, Distributed Ledger Technologies (Blockchain), Nanotechnology and Cybersecurity, will underpin the process of cross sectoral digital transformation, which is critical to ensuring the Irish economy maintains its competitive edge as we transition to the new digital economy. Even before the pandemic, the output of high-level ICT skills from Ireland's education and training system was failing to keep pace with demand across the economy; this shortfall was increasingly being addressed by the inward migration of international ICT talent.

17. What was once largely an issue confined to the Technology Sector now represents an all of economy skills need and is driving demand even higher- at a time when domestic supply and competition for international ICT talent is already acute. This is also reflected in the cross sectoral importance of digital skills more broadly, which have become a core competency at both workforce and managerial level. Recent trends in technology sector employment should not be considered reflective of longer-term demand- the future remains digital. Even before the impact of the pandemic on the speed of digital transformation, the EGFSN was forecasting at least 8.5% annual growth in demand for High Level ICT skills up to 2022.

18. Development of the longer-term pipeline for digital skills is being addressed through commitments under the *Digital Strategy for Schools,* such as digital literacy and computer science programmes at primary and secondary level, and technology enhanced learning strategies across FET and Higher Education. Implementation and realisation of the ambitions in the *STEM Education Policy Statement*- in particular around female participation- and the broader rollout and resourcing of the Computer Science Leaving Certificate programme can play a key role in fostering the ICT Skills pipeline. This should include the better resourcing of girls' schools to facilitate STEM and Computer Science provision.

19. The expansion of STEM provision, however, could be frustrated by difficulties in the recruitment of teachers. In common with the staffing experience at tertiary level, competition from the private sector and its better financial rewards can serve to reduce the pool of specialist teachers for STEM and computer science.

20. In terms of the FET, Higher Education and lifelong learning response, this should build on the three ICT Skills Action Plans since 2012, in particular the close cooperation between Government, industry and the education and training sector, in order to attract a pipeline of new entrants into ICT programmes, maximise the capacity and investment in education and training in this area, and provide the upskilling pathways that ensure Ireland's pool of ICT professionals can keep pace with technological trends.

21. Skillnet Ireland, and in particular its Technology Ireland ICT Skillnet, has worked closely with IDA Ireland, Enterprise Ireland and a range of companies across the technology sector in rolling out innovative programmes in cutting edge areas such as Artificial Intelligence, Blockchain, Data Analytics and Cybersecurity. These programmes have incorporated flexible online or blended programme delivery, which has facilitated the participation of the existing technology sector workforce.

22. EGFSN research has also highlighted the importance of soft or transversal skills in fully exploiting the potential of technology and digital transformation, particularly at management level, during periods of rapid or unexpected change. These include leadership skills, which entail innovative thinking on how technology can be used to improve processes and business activities; interpersonal skills (facilitation of change management, conflict resolution), to maintain a positive and productive culture within an organisation; and business skills, for effective project management.

The Transition to a Zero Carbon Economy and Ireland's Housing and Infrastructural Needs

23. In late 2021 the EGFSN published *Skills for Zero Carbon- The Demand for Renewable Energy, Residential Retrofit and Electric Vehicle Deployment Skills to 2030,* which sought to support delivery of some of the key enabling measures in the Government's Climate Action Plan: 5GW of offshore and up to 8GW of onshore wind energy generation, 1.5-2.5GW of solar energy generation, the energy efficient retrofit of 500,000 homes to a minimum B2 BER, the installation of 600,000 heat pumps, and the target of having 840,000 electric cars, and 95,000 commercial vehicles, on Irish roads.

24. The report details how the transition to a zero-carbon economy will lead to changes in sectors and occupations, the phasing out of existing roles, but also demands for new skills and

competencies, as well as employment opportunities, in the new Zero Carbon economy. The study forecasts that employment in wind and solar energy generation will have to increase to 9,000 (from a 3,000 baseline) by 2030, while the workforce engaged in residential retrofit and heat pump installation will similarly have to ramp up quickly and increase more than fourfold (from c.4,000), to stand at over 17,000 for the remainder of the decade. The existing motor mechanic workforce will meanwhile need to be transitioned to work on Electric Vehicles as EV uptake increases.

25. The report highlights a range of STEM disciplines that will support, in particular, the expansion of Ireland's renewable energy capacity. These include the range of engineering disciplines (civil, environmental, structural, mechanical, electrical, production and process, quality control and planning, telecommunications), physical scientists (geologists, meteorologists, acoustic experts, shadow flicker experts), conservation professionals (ecologists, ornithologists, marine biologists, for Environmental Impact Assessments), environmental professionals (environmental scientists, carbon accounting experts), wind turbine technicians, and solar technicians.

26. Generating the required workforce for Ireland's zero carbon transition effectively involves the development and channelling of talent to what are new or emerging sectors. This will require the definition and promotion of career opportunities, as well as associated education and training pathways to students, guidance professionals and professionals through industry and government outreach. The embedding of 'green' content across relevant second level provision will also be key to raising awareness around career opportunities and securing a flow of new entrants to relevant FET or third level programmes.

27. At tertiary and CPD level, there is a need to prioritise training for emerging occupations in onshore and offshore energy and energy systems, to expand offshore and maritime training, to upskill existing engineering and environmental professionals in zero carbon areas and increase the exposure of third level engineering, environment and planning students to Renewable Energy content. The creation of direct pathways into Emerging and Niche Renewable Energy occupations should also be explored and the skillsets of the workforce extended into a range of areas, including commercial and digital skills, health and safety and effective communication, in particular for consumer or stakeholder engagement.

28. STEM skillsets will also be required in supporting the delivery of Ireland's housing new build, infrastructural and built environment energy efficiency ambitions in the coming decade- in particular civil, mechanical and electrical engineers (as well as retrofit, there will be a strong construction skills component to the construction phases of renewable energy developments). This has been reflected in the EGFSN's 2020 report *Building Future Skills, Skills for Zero Carbon,* and its 2021 input into the development of *Housing for All, Labour Demand Estimates for Ireland's National Housing Targets, 2021-2030.*

29. As the Built Environment sector increases its adoption of technology, and in the medium term, a potential transition to Modern Methods of Construction, the importance of STEM skillsets, as opposed to traditional craft skills, can be expected to increase. For roles within the Built Environment sector, initiatives under *Housing for All* are seeking to address the negative perceptions around career attractiveness and viability that have impacted Construction since the 2008-10 downturn. The ambitions and investment commitments around housing, infrastructure and climate action, however, will support the longer-term stability of construction activity and its career opportunities.

30. Tackling the gender imbalance within the sector will also require interventions at school level- in particular the affording of access to female students at Junior and Senior cycle level to Built Environment facilities and course options, including design and communication graphics (technical drawing, technology, engineering, applied maths and construction studies.

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2023/165

24th May, 2023.

Ms. Tara Kelly,
Clerk to the Committee,
Joint Committee on Education, Further and Higher Education, Research, Innovation and Science,
Leinster House,
Dublin 2.
D02 XR20

Dear Ms. Kelly,

Thank you for the invitation to submit our observations as part of the Committee's examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education. Our submission represents the collective input of a suite of Faculties within TU Dublin, in particular the Faculty of Engineering & Built Environment, the Faculty of Sciences & Health, and the Faculty of Computing, Digital & Data.

We note the terms of reference of the report, and we have structured our response accordingly. In recognition of the advanced state of the Committee's consideration of the topic, we have opted to present our points succinctly. We would be more than happy to elaborate on any element if that would be helpful.

STEM in Primary Education

Multiple research studies have demonstrated that children as young as age six endorse stereotypes that girls are less interested than boys in computer science and engineering (Master, Meltzoff & Cheryan, 2021) and believe that boys are better than girls in some STEM subjects such as programming (Master, Cheryan, Moscatelli & Meltzoff, 2017).

- The primary curriculum should be amended to foster an interest in STEM, primarily through the use of practical examples in the classroom. This should aim to foster the child's capacity to understand and engage fully with the world around them, with an emphasis on problem-based learning using basic STEM principles. A simple toolbox of STEM activities could be deployed across primary schools. Consultation with stakeholders in the design of this would be important.

- Consideration should be given to gearing school tours towards fun STEM-related sites such as hi-tech manufacturing plants and data centres, Universities, and museums. Engagement with a gender-balanced selection of employees can serve as early role models for all children.

STEM in Post-Primary Education

- The curriculum should be developed further to build on the capacity to understand and use STEM through building knowledge, skills, and competencies.

- Greater investment should be made available for laboratory and workshop facilities in schools to emphasise the practice-based nature of STEM subjects.

- Transition year programmes should include engagement with local STEM industries and site visits to hi-tech manufacturing plants, data centres, Universities, museums, etc.

- Consider an alteration of the CAO points system, or development of pathways through Further Education establishments, to allow students with strengths in particular STEM subjects to gain access to relevant programmes at tertiary level.

STEM in Tertiary Education

- As the STEM sector is fast evolving, investment is required to keep tertiary educational institutions equipped to teach the most up-to-date knowledge. Investment funding for infrastructure and equipment, ideally on a multi-annual basis, is important to enable optimal planning of educational offerings.

- Enabling National Training Fund resources to be deployed for the development and acquisition of microcredentials would broaden the skills-base of working-age adults.

- Expanding the available funding for apprenticeships would enable a greater number of skilled workers.

- Level 9 and level 10 education are quickly becoming the new norm for high skilled jobs in the STEM sector. Investment in research infrastructure and funding streams is required to upskill level 8 STEM graduates to attain higher degrees (in particular, in the areas identified in the National Research Prioritisation Exercise). Sufficient funding schemes should be in place to support the parallel upskilling of employees through employment-based research.

- Ireland has invested in Technological Universities to help deliver its national ambition for STEM but has not yet invested in the appropriate staffing of the sector. The recommendations contained in the recent OECD 'Review of Technological University Academic Career Paths, Contracts and Organisation in Ireland' need to be implemented by government, including both the academic workload model (to encourage greater research

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output) and the career framework (to enable the sector to compete for talent with longer-established universities).

Female Participation, Diversity and Inclusion in STEM

- Develop a scheme to encourage STEM employers to identify positive role models that can engage with students in education, from primary through to tertiary levels, and challenge existing stereotypes and biases.

- Consider the provision of funding to support widening participation in Higher Education, targeted initiatives at DEIS schools and at under-represented groups including gender, travellers, direct provision applicants, and those with disabilities.

- Support universities in the development of STEM graduate networks and mentorship networks that follow the graduate after they leave University, that supports them in their career, and that builds an inclusive professional environment.

Digital Strategy in Education to Support STEM Education

- Provide funding to support the acquisition of Virtual Reality and Augmented Reality equipment by primary and secondary schools to support STEM education and to equalise the exposure of all students to its practical aspects.

- Consider the use of online learning – from primary level right through to tertiary education – to widen the exposure of students to experts in industry.

I hope that these observations and recommendations are helpful to the Committee in its deliberations. My staff and I would be more than happy to elaborate on any of these points and to engage further with the Committee as you see fit in the development of your final report.

Thank you again for enabling TU Dublin to make this submission.

Yours sincerely,

Professor David FitzPatrick,
President.

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Submission to the Joint Committee on Education, Further and Higher Education, Research, Innovation and Science on its examination of the Future of Science, Technology, Engineering and Maths (STEM) in Irish Education.

June 2023

ILMI (Independent Living Movement Ireland) is a campaigning, national representative Disabled person's organisation (DPO) that promotes the social model of disability and seeks to build an inclusive society. Central to the way we work is to ensure that policy decisions that impact on the lives of disabled people have to be directly influenced by those whose lives are directly affected.

We are working collectively to create a collective Disability Rights Movement in Ireland which is led by disabled people and promotes a rights-based social model of disability, challenging the unacceptable charity / medical model of disability. We are working towards the removal of societal barriers that prevent active equal participation of disabled people, challenging the denial of people's rights

Our philosophy can be summed up as: 'Nothing about us without us!' and 'Rights Not Charity'. Our vision is an Ireland where disabled persons have freedom, choice and control over all aspects of their lives and can fully participate in an inclusive society as equals.

It is our objective to create an Ireland where disabled people, regardless of age or impairment, have the same responsibilities and range of choices as everybody else. This includes housing, transportation, employment; meaning full participation in the social, economic and political life of their own communities and access to a fair education at primary, secondary and tertiary levels. .

Science, Technology, Engineering and Maths are crucial areas of not only our education system but also to our economic and social advancement. The subject areas play an essential role in how Irish society is structured and technological and scientific advancements in our contemporary moment and indeed in the future are of enormous importance to the advancement of the state, environment and our population. However, even with the government’s drive to attract more young people to the areas of STEM, there exists significant challenges, and in many instances barriers, when disabled students express a desire to engage with these subjects at all levels of the education system and further on when seeking employment.

When considering the current and future approach of STEM, it is crucial to respect Ireland's commitments under the United Nations Convention on the Rights of People with Disabilities (UNCRPD) and particularly Article 24 of the Convention which articulates, “The State recognises that disabled people have the same rights as others to education”

As a national Disabled Persons Organisation, we are concerned that there has been a failure and there is a continued failure to have full and equal access to STEM for some disabled people. Therefore denying the right and opportunity for disabled students to experience subjects which can be exciting, innovative and thought-provoking. Furthermore, with this systemic deficiency, there is also a economic and social missed opportunity. There are thousands of educated, driven and eager disabled young people and more mature students that have the right aptitude and initiative to significantly contribute to our country’s reputation as an innovator in the fields of STEM, yet these are often ignored.

Indeed, some disabled people use various forms of technology in their everyday lives, such as environmental Controls for their homes, mobility appliances, etc., and so can have an inherent curiosity and appreciation of the significant role of STEM in the development of these active technologies.

Nonetheless, there are many barriers within the education system for disabled people which inhibits them from achieving full equal participation, the same as their non-disabled peers. The barriers include accessibility, attitudinal barriers, accessing resources and accessing appropriate supports. Moreover, there is often a low expectation of the disabled student and a tendency to push them towards disability specific service provider’s employment supports. Frequently, this is inappropriate. This is not inclusion or equity, this is another, more subtle, yet damaging, form of segregation and exclsuion.

STEM in Post-Primary Education:

The transition from primary to secondary education can be a daunting yet exhilarating period for all students as it is the first time many students get a choice on what subjects they want to study.

This is where some disabled students can experience systematic discouragement from participating in STEM, particularly in subjects of Science, Technology and Engineering due to some educators' attitudes and health and safety concerns.

Disabled students, on occasion, are not given the opportunity to pursue a subject like science beyond Junior Certificate level and continuing with one of its elements, Biology, chemistry or physics at leaving cert if they have a physical impairment. It is perceived that this subject matter is too complex or physically demanding for the disabled student to complete the practical element of the course. Educators need to be made aware of the social model of disability – for instance with the engagement in authentic Disability Equality workshops, and talk directly with the disabled student to ensure equal access to all STEM subjects and be assured the disabled person is the expert in what they can and cannot do.

Additionally, there is a requirement to be more flexible in how students can participate in the practical fundamentals of the courses. For instance, in the use of Assistive Technology when required in practical classes and or the use of a personal assistant to carry out tasks on the professional direction of the student.

STEM in Tertiary Education:

Disabled students have found, in some instances, they have not been encouraged to undertake a degree in the areas of STEM. This may be a result of career guidance offered to students which, despite our adoption of the CRPD and its commitment and the state's obligation to disability rights, is very much still situated in the medical/charity model of disability. Frequently disabled students are perceived as "might not be able for the job" .The effect of adopting such a redundant ideology is a negation of the skill set, academic ability and aptitude of the disabled student.

Ultimately, it is the students who choose what they want to study. Again, many of the barriers faced by disabled students in third level are lack of training and knowledge within the education system of the social model of disability.

Nonetheless, examination supports in universities and colleges can be positive, such as additional time for an exam or a different centre. Supports such as note takers get general training but not specific to support people's varying impairments or study a particular area such as engineering, which can be challenging for the disabled person.

Many courses available in the STEM area have a work experience component to that is crucial to the student's practical an academic experiences and skill set. Many students are required to complete a dissertation on the knowledge and experience the student has attained during their employment involvement. Disabled students are often not valued the same when compared to their non-disabled peers. Disabled students sometimes do not receive the entire experience of meaningful work placement and therefore miss out on a valuable opportunity to use their knowledge and gain new skills and indeed put the skills they have learned in college into use.

Female Participation, Diversity and Inclusion in STEM;

Diversity, accessibility and Inclusion are fundamentally important now and in the future of stem in Irish education. Science, Technology, engineering, and maths play a central part in many of our crucial industries, and the skills of analysing and problem-solving which form the cornerstones of many stem subjects are used by many in everyday life.

Representation is essential to encourage students and should reflect the actual diversity of humanity. There should be a concerted effort to engage with female disabled students at secondary level and to support them to enter the areas of STEM however, central to this effort requires a systematic changes towards a more holistic and social model perception of disability must occur.

Having a diverse skill set, and workforce, can only is a positive metric of how equitable our society truly is. Disabled people are natural problem solvers who negotiate many barriers – structural and attitudinal in their everyday lives. Problems become challenges for disabled people in need of solving and more often than not it is us as disabled people that find the answers to our predicaments. This is a unique and valuable skillset, beneficial to disabled people, industry and our society as a whole. Why is this overlooked?

The Disabled Person's Organisations (DPO) Network Submission to the

Joint Committee on Education, Further and Higher Education, Research, Innovation and Science

Topic - Science, Technology, Engineering and Mathematics (STEM)

Submitted on 29th June 2023

Introduction

This submission, by the DPO Network includes feedback from the Irish Deaf Society (IDS) and the Disabled Women Ireland (DWI) on behalf of the network.

The DPO Network is an Irish alliance of Disabled People and their organisations (five DPOs) who have joined together as we have a common interest in the implementation of the UN Convention on the Rights of Persons with Disabilities in Ireland.

The five DPO member organisations of the DPO Network are:

- As I Am - Ireland's National Autism Advocacy Organisation
- Disabled Women Ireland (DWI)
- Independent Living Movement Ireland (ILMI)
- Irish Deaf Society (IDS)
- National Platform of Self Advocates

The DPO Network is committed to the human rights and social model of disability which says that the exclusion, inequality, and discrimination that disabled people experience is not the consequence of our impairments but a result of the economic, cultural, social, and political barriers which are created and persist in society.

The DPO Network and Irish Deaf Society have previously made submissions to the Joint Committee on Disability Matters on the topic of the "Review of the Education for Persons with Special Educational Needs (EPSEN) Act 2004" in March 2023. We have included those submissions as appendices to this document as the contain complementary commentary and perspectives on the importance of access and early intervention when it comes to education for disabled people and Deaf people, points which are all relevant when looking at access to STEM.

This document will examine a variety of points to consider when looking at access to STEM for disabled people and Deaf people.

Points raised by Disabled Women Ireland:

1. **Disproportionate Impact of Classes Over Quota**: The lack of science teachers and classes operating over quota sizes has a disproportionate impact on students who require additional support. Deaf students and those with specific learning differences, such as dyscalculia, face significant challenges in accessing appropriate resources and assistance in STEM subjects. It is essential to address the shortage of qualified teachers in these areas to ensure that all students receive the support they need to succeed.
2. **Support for Specific Learning Differences:** Support for students with specific learning differences should extend beyond core subjects and encompass STEM education. For example, individuals with dyscalculia, a specific learning difficulty related to mathematics, require specialised support to overcome barriers in understanding and engaging with STEM concepts. By providing comprehensive support tailored to specific learning differences, we can foster an inclusive and accessible learning environment for all students.
3. **Impairment-Related Challenges in STEM:** Impairment-related challenges, such as limited hand-eye coordination, pose significant obstacles to the participation of Deaf students and others with physical impairments in the practical aspects of STEM subjects like chemistry and biology. Unfortunately, these subjects have not received the same level of support as core subjects like Irish, English, and Maths. It is crucial to develop an adapted curriculum and embrace Universal Design for Learning principles across all disciplines, including the Arts and Sciences, to ensure equal opportunities for all students.
4. **Proactive Universal Design and Support:** At third-level education, there is often an excessive emphasis on self-advocacy, placing the burden on students to secure accommodations and support themselves. It is essential to shift the focus towards proactive Universal Design for Learning and provide comprehensive support systems for STEM students. This includes raising awareness about available accommodations, reducing administrative burdens, and fostering positive academic relationships that do not rely solely on students' ability to advocate for themselves. Mentorship programs can play a vital role in supporting students' academic and career development.
5. **Intersectional Challenges for Disabled Women and Girls:** Disabled women and girls face additional obstacles in pursuing STEM fields due to gendered factors, which are compounded by disability-related challenges. They often experience underestimation in educational settings and harsher social judgment when advocating for their access rights. It is important to address these intersectional challenges by promoting gender equality, providing tailored support, and creating inclusive environments that empower disabled women and girls to thrive in STEM education and careers.
6. **Addressing Educational Gaps and Uneven Access:** Disabled young people are more likely to experience uneven access to education, including difficulties in securing appropriate school

placements. These challenges can result in educational gaps that significantly impact their foundational learning in STEM subjects. To mitigate these effects, it is crucial to provide tailored support programs and interventions that enable disabled students to catch up and bridge any educational gaps, particularly in STEM subjects, which form the basis for further learning and career opportunities.

Points to consider with specific reference to Deaf people and Irish Sign Language:

1. **Insufficient Funding for ISL Vocab for STEM:** The existing ISL glossary project, which seeks to develop ISL vocabulary for STEM concepts, is severely underfunded. Without an adequate budget, progress in this area remains limited, hindering Deaf students' comprehension and engagement with STEM subjects. We strongly recommend that the government allocate appropriate funding to support the expansion of this project, ensuring comprehensive and accurate ISL resources for STEM education.

2. **Limited ISL Proficiency among Teachers:** Article 24 of UNCRPD stipulates that Governments must respond appropriately to employ teachers fluent in sign language and professionally trained to teach Deaf children. However, there is currently no mandatory qualification for teachers working with Deaf children in mainstream school and schools for Deaf children. The situation is far from satisfactory especially when we consider the rights of Deaf children to access education through the medium of ISL and be taught by qualified and competent teachers has been upheld by UNCRPD. This limitation and lack of fluency impacts the quality of instruction and impedes students' ability to fully grasp complex STEM concepts. We encourage the Department of Education to invest in specialised training programs that enhance teachers' ISL skills, enabling them to effectively communicate and support Deaf students' educational needs in STEM subjects.

3. **Resource Disparity in Deaf Schools:** Deaf schools often face resource limitations compared to mainstream schools. With smaller student populations, these schools may struggle to offer a wide range of subjects, limiting Deaf students' opportunities to pursue their interests in various fields, including STEM. We urge the committee to address this issue by advocating for increased resource allocation to Deaf schools, ensuring equitable access to STEM education for all students.

4. **Lack of Response to Proposals:** We are disheartened by the lack of response we received from the Department of Education regarding our proposal to amend the ISL home tuition scheme. This proposal aimed to enhance the provision of ISL support for Deaf students studying STEM subjects. We urge the committee to investigate this matter and emphasise the importance of prompt and transparent communication between relevant authorities and organisations representing Deaf individuals.

5. **Lack of Accessible Online STEM Resources in ISL:** While there are abundant online resources available for self-learning in STEM subjects, it is disheartening that these resources are not

available in ISL, making them inaccessible to Deaf students. We recommend that the government collaborates with educational technology developers and content creators to produce ISL-accessible materials for online STEM resources, thus enabling Deaf students to fully participate in self-learning and independent study.

6. **Consultation with DPOs:** Consultation in relation to Deaf education and students must be sought from Deaf experts in this area. As outlined under the UNCRPD, disabled people and our representative organisations must be consulted on all decisions which impact our lives, not just on legislation specifically focussing on disability. The UNCRPD also states that DPOs must be involved in consultation processes from the planning or design stage onwards.

Conclusion:

In conclusion, our submission highlights important issues regarding disabled people and Deaf people's access to STEM education.

It is crucial to address the disproportionate impact of classes over quota sizes on students who require additional support, such as those with specific learning differences like dyscalculia. Impairment-related challenges in STEM, including limited hand-eye coordination, must be acknowledged, and accommodated to provide equal opportunities for all students. Proactive universal design and support, rather than relying solely on self-advocacy, are essential for creating inclusive learning environments. Intersectional challenges faced by disabled women and girls in STEM education must be recognised and addressed, while efforts to bridge educational gaps and ensure equal access should be prioritised.

In relation to Deaf students several areas must be addressed. Insufficient funding for the development of ISL vocabulary in STEM hinders Deaf students' comprehension and engagement with these subjects. The limited proficiency of teachers in ISL further impedes effective communication and support for Deaf students in STEM education. Resource disparities in Deaf schools restrict the opportunities for Deaf students to pursue their interests in STEM subjects. The lack of response from the Department of Education regarding our proposals underscores the need for transparent communication and prompt action. Furthermore, the absence of accessible online STEM resources in ISL limits Deaf students' ability to engage in self-learning. Finally, we emphasise the importance of consulting Deaf experts and involving DPOs in decision-making processes to ensure that the rights and needs of Deaf individuals are properly addressed.

By considering these important points, we urge the Department of Education to take necessary actions to enhance access to STEM education. Through proper funding, teacher training, resource allocation, accessible materials, and meaningful consultation, we can create an inclusive and equitable educational landscape that empowers disabled people and Deaf individuals to fully participate and excel in STEM fields.

Supporting Documents

Irish Sign Language Act 2017: https://www.irishstatutebook.ie/eli/2017/act/40/enacted/en/html

Deaf Education position paper: https://www.irishdeafsociety.ie/about/policy-paper-deaf-education/

The Education of Deaf and Hard of Hearing Children in Ireland – NCSE Policy paper: https://ncse.ie/wp-content/uploads/2014/09/DeafEducationReport.pdf

The Irish Deaf Society Strategic Plan: https://www.irishdeafsociety.ie/about/strategy/

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While the information contained in this submission was accurate and up to date at the time of its completion, it is important to note that language and information are constantly evolving. As time progresses, new developments, interpretations, and understandings may emerge, potentially rendering certain aspects of this submission outdated or less relevant. Therefore, we strongly encourage individuals to exercise caution and verify the appropriateness and accuracy of the information provided if utilising it at a later stage.

For further information regarding the information stated above, please contact John Sherwin, CEO of the Irish Deaf Society and secretary for the DPO Network – ceo@irishdeafsociety.ie.

APPENDIX 01 – DPO Network Submission on EPSEN March 2023

The Disabled Person's Organisations (DPO) Network Submission on the Education of Persons with Special Educational Needs (EPSEN) Act 2004.

Introduction

The Disabled Person's Organisation (DPO) Network welcomes the opportunity to provide a submission on the Education of Persons with Special Educational Needs (EPSEN) Act 2004.

The five DPO member organisations of the DPO Network are:

- Disabled Women Ireland
- Irish Deaf Society
- Independent Living Movement Ireland (ILMI)
- The National Platform of Self Advocates
- AsIAm

Collectively, the DPO Network is committed to the realisation of the UN Convention on the Rights of Persons with Disabilities (UN CRPD), wherein disabled people are entitled to an education under Article 24. Furthermore, we are committed to the human rights and social model of disability which says that the exclusion, inequality, and discrimination disabled people experience is not the consequence of our impairments but a result of the economic, cultural, social, and political barriers which persist in society. All our work is led and informed by the active participation of disabled people based on their lived experience. Given the broad membership base of the members of the network, the Network gives a unique space for a genuinely cross-impairment analysis of the issues faced by disabled people and provides a space for networking between the organisations.

Under Article 41 of the Irish Constitution and Article 28 of the UN Convention on the Rights of the Child (UN CRC), children living in Ireland have the right to an education. This right is reaffirmed in Article 24 of the UN CRPD, which states that all disabled people, including children, have the right to an education on an equal basis with others[1].

In this submission, we highlight the key recommendations of each of the five DPO Network members, which are discussed in greater detail in each organisation's own submission.

Disabled Women Ireland:

DWI is Ireland's only national cross-impairment Disabled Persons' Organisation (DPO)[2] representing disabled women, girls and non-binary people. DWI is an unfunded, entirely voluntary all-island organisation.

Key Recommendations:

1. Amend the EPSEN Act to ensure the adoption of an inclusive education system, informed by the principles of Universal Design for Learning, across all educational settings as required by the State's obligations under the UN Convention on the Rights of Persons with Disabilities.
2. The Departments of Education and of Children, Equality, Disability, Integration and Youth should co-create a dedicated National Strategy or appropriate and actionable policy framework, with measurable timeframes and targets to prioritise transition from the current segregated educational system to an inclusive UNCRPD-compliant system. Goals and targets of this strategy should be identified in close consultation with disabled people through their CRPD-identified representative organisations, with a particular focus on prioritising the input of disabled children and young people. We further recommend that the relevant Ministers provide an annual update on implementation of the strategy to the Dail and to relevant CRPD monitoring bodies, such as IHREC.

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[1] Article 24: Education; UN Convention on the Rights of Persons with Disabilities.

[2] A DPO is an organisation whose primary focus is advocating for the rights of disabled people where a clear majority at all decision-making levels are disabled people themselves, as defined under General Comment No. 7 (2018) of the UN CRPD: http://docstore.ohchr.org/SelfServices/FilesHandler.ashx?enc=6QkG1d%2FPPRiCAqhKb7yhsnbHatvuFkZ%2Bt93Y3D%2Baa2pjFYzWLBu0vA%2BBr7QovZhbuyqzjDN0plweYI46WXrJJ6aB3Mx4y%2FspT%2BQrY5K2mKse5zjo%2BfvBDVu%2B42R9iK1p

3. Implement the EPSEN Act in its entirety, ensuring that disabled children have statutory rights to individualised educational assessments, educational plans and related supports as well as an independent appeals process
4. DWI strongly recommends a complete ban on the use of seclusion and restraint in school settings, as recommended by the CRC Committee.
5. While transitioning to a complete ban on the use of seclusion and restraint, we also recommend that educational settings be required to report instances of seclusion and restraint to parents and guardians, that data into the use of such practises be collected, and research into their impact be conducted, and access to a complaints mechanism be provided.
6. Amend the EPSEN Act to ensure that disabled children are involved in all aspects of having their individual educational requirements met, including educational assessments, the creation of individualised educational plans and reviews.
7. Ensure access to support and a wide variety of communication methods is embedded across law and policy related to EPSEN to facilitate children and young disabled people to express their views
8. Collect disaggregated data in relation to disabled children in education and ensure that it is sent to Disabled Persons' Organisations (DPOs) in accessible, transparent formats.
9. Ensure that future consultations are fully accessible to disabled people, through engaging with DPOs
10. Adopt a systematic approach to providing alternative, accessible formats of all documents (policy and legislation) to ensure children and young people can participate in consultation processes and express their views on an equal basis with others.

Irish Deaf Society:

The IDS is the only national Deaf-led representative organisation of the Deaf, and it serves the interests and welfare of the Deaf community. It provides a number of education, personal and social services to Deaf children, adults, and their families. The Irish Deaf Society is recognised as a Disabled Peoples Organisation (DPO) under the UN Convention on the Rights of Persons with Disabilities (CRPD).

Key Recommendations:

1. Include and recognise Irish Sign Language as a language within the EPSEN Act and encourage its use in all educational settings.
2. Consultation in relation to Deaf education and students must be sought from Deaf experts in this area
3. Collect data relating to the educational outcomes of Deaf students.
4. Encourage the employment of Deaf people in schools with Deaf students.
5. Include Irish Sign Language within the school curriculum
6. Improve the ISL tuition scheme as recommended in the IDS Deaf Education paper (linked below in supporting documents)
7. Reform and promote the ISL Tuition Scheme as recommended in the IDS Deaf Education paper (linked below in supporting documents). Many hearing parents are unaware of this scheme.
8. Reasonable accommodations including assistive technology (such as captioning, real-time translation and assistive listening devices) should be made available to Deaf students who do not use ISL in the classroom.

Independent Living Movement Ireland:

ILMI is a national Disabled Person’s Organisation (DPO) that works to build an inclusive and equitable society for disabled people in Ireland and internationally. Our values of agency, collective empowerment and social justice are at the very core of all our work.

Key Recommendations:

1. The EPSEN act must be implemented fully and in line with UNCRPD.

2. Disability equality must be central to all decisions made and enacted by the EPSEN act with disabled students and their allies central to the process and outcomes that affect them.
3. Include Disability Equality training and workshops into the educational system as part of a wider emphasis on equality and diversity. This must be distinct from Disability Awareness – a practice that is outdated, and must be delivered by DPOs. Disability Equality included to the circular will make for a more contemporary, fairer and holistic approach to education and society.

The National Platform of Self Advocates:

The National Platform of Self Advocates is an independent Disabled Person's Organisation run by people with intellectual disabilities for people with intellectual disabilities.

Key Recommendations:

1. Special needs assistants should be made available to children with intellectual disabilities from the start of primary school. This would prevent children from having to go to special schools because they don't have the support needed to take part in ordinary schools.

2. All teachers should be taught how to teach and communicate with people with intellectual disabilities. This would make it easier for students and teachers to understand each other.

3. Teachers should be taught how to use plain English. Writing and presenting information in plain English benefits everybody. It helps all students to understand and makes classrooms more inclusive.

4. People with intellectual disabilities should be employed in appropriate jobs in schools and be visible to everybody. This helps to create a positive attitude towards disabilities. It makes environments more inclusive and increases the expectations people have of individuals with intellectual disabilities.

5. Make sure that the EPSEN Act is updated to be in line with the UNCRPD.

AsIAm:

AsIAm is Ireland's national Autism charity and advocacy organisation, working to create a society in which every autistic person is empowered to reach their own personal potential and fully participate in society.

Key Recommendations:

1. Introduce longer term systemic and structural reforms which support every child’s right to be educated and be included in a mainstream classroom with their peers in their local school
2. Increase accessibility of classrooms and schools in line with Universal Design.
3. Fully implement the EPSEN Act and update the Act to reflect a Social Model/Human Rights understanding of disability and best practices for inclusive education under the UNCRPD and UNCRC;
4. Increase training and opportunities for professional development for teachers and SNAs, on training which focuses on child-centred, neuro-affirmative approaches to supporting autistic pupils and pupils at school.
5. Improve data collection in relation to disabled children to enable better future planning and to better support autistic and disabled children to access an education in their local school;
6. Implement measures which result in greater recognition of the essential role of Special Needs Assistants, support teachers and therapists, and provide for their inclusion and integration into the education system, including mainstream classrooms and schools.
7. Ensure that all students can access reasonable accommodation and are provided with an accessible curriculum
8. Introduce statutory guidelines around the use of suspensions and expulsions, and for the elimination of seclusion and restraint.
9. Ensure statutory rights to Individual Educational Plans and Educational Assessments.
10. Expand the role of Children’s Disability Network Teams across a range of education settings, to ensure that pupils can access Speech and Language Therapists, Occupational

Therapists and Psychologists that meet their needs in their locality and ensure greater investment in disability services in conjunction with Progressing Disability Services, to meet these needs accordingly.

11. Improve communication and coordination between other departments/ divisions and agencies

Access issues with the consultation process

In addition to raising our concerns about the EPSEN Act, we also wish to highlight ongoing access issues with the current consultation process. While the Department's willingness to accept submissions in formats other than the online survey via email is welcomed, it is important to note that no postal address was given for submissions to be sent in hard copy. Additionally, information about the consultation process itself was not provided in Plain English, Easy-to-Read or Irish Sign Language, limiting the ability of many disabled and d/Deaf people to participate in this process. Members of the DPO Network also highlighted that the vagueness of the survey questions was also inaccessible. Organisations within the DPO Network also contacted the department via the provided email address to ask questions about the consultation, but didn't get any response – creating challenges for those of us providing full submissions.

It is also important to note that under the UN CRPD, the State has a responsibility to **actively** consult with disabled people through their representative organisations (Article 4.3) which, to our knowledge, has not happened. In addition to ensuring that the views of disabled people contribute to the review itself, active consultation with DPOs is essential to support DPOs, which are chronically under-resourced and underfunded, to contribute meaningfully to this process. DPOs can also support and advise government departments in ensuring that consultations are conducted in an accessible manner.

We are also concerned about the involvement of disabled children in this consultation process. While there are currently no DPOs for children in operation in Ireland, it is absolutely essential that the views of disabled children are actively sought out and prioritised in this process and that appropriate supports are provided to facilitate their involvement.

Supporting Documents:

1. Deaf Education position paper:
   https://www.irishdeafsociety.ie/about/policy-paper-deaf-education/

2. IDS NCSE Submission:
   https://ncse.ie/wp-content/uploads/2014/09/DeafEducationReport.pdf

3. NDA Participation Matters Guidelines on implementing the obligation to meaningfully engage with disabled people in public decision making:
   https://nda.ie/uploads/publications/NDA-Participation-Matters_Web-PDF_092022.pdf

APPENDIX 01 – IDS Submission on EPSEN March 2023

Irish Deaf Society Response to the

Review of the Education for Persons with Special Educational Needs (EPSEN) Act 2004

Submitted on 3rd March 2023

Introduction

This document is a response to the Department of Education's review of the Education for Persons with Special Educational Needs (EPSEN) Act 2004 and is submitted by the Irish Deaf Society (IDS). The IDS is the only national Deaf-led representative organisation of the Deaf, and it serves the interests and welfare of the Deaf community. It provides a number of education, personal and social services to Deaf children, adults, and their families.

The Irish Deaf Society is recognised as a Disabled Peoples Organisation (DPO) under the UN Convention on the Rights of Persons with Disabilities (CRPD). IDS are members of the World Federation of the Deaf and the European Union of the Deaf and have consulted with international Deaf representative bodies in relation to a number of societal issues that impact on Deaf people.

The Irish Deaf Society leads the ISL Act Cross Community Group, which is a group of National organisations and service providers working in the Deaf community. We consult with this group in relation to topics of interest to Deaf people including the ISL Act and the topics discussed in this submission. This group includes the following members: Bridge Interpreting, Centre for Deaf Studies (CDS) TCD, Chime, Council of ISL Interpreters of Ireland (CISLI), Council of ISL Teachers (CISLT), Greenbow LGBTQ+, Irish Deaf Research Network (IDRN), Irish Deaf Youth Association (IDYA), National Deaf Women of Ireland (NDWI), Sign Language Interpreting Service (SLIS).

There are no accurate statistics on the size of the Deaf community in Ireland, but it is estimated that 5,000 people communicate in Irish Sign Language (ISL) as their primary language together with a community of an estimated 40,000 including family, friends and those working in the Deaf community. The most recent data from the central statistics office show there are over 103,000 people who are deaf and hard of hearing in Ireland. However, not all communicate in ISL as their primary language, or many may not consider themselves to be part of the Deaf community. The IDS use the term Deaf to cover all Deaf people, regardless of the degree of hearing they have.

This document will highlight our recommendations of points to be considered in the review of the EPSEN Act.

Points to be considered

1. The Irish Sign Language Act 2017 recognises Irish Sign Language (ISL) as the indigenous language used by the Deaf community in Ireland. This official recognition of ISL as a language is a significant step forward from the mention of sign languages in the Education Act 1998, where ISL is listed under 'service provision' in Section 72. The ISL Act 2017 contains 11 clauses covering Deaf people's right to use ISL as their native language and the obligation on public bodies to provide information, resources, and public services through ISL. Public bodies in this instance include the Department of Education, Schools as Public Service Bodies, National Council for Special Education (NCSE), National Council for Curriculum and Assessment (NCCA) and the Teaching Council of Ireland.

   The United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), ratified by the Irish Government on 8th March 2018, strengthens this emphasis on the rights of Deaf people to access education through the medium of ISL. For example, UNCRPD Article 24 states that "States Parties shall take appropriate measures to facilitate the learning of sign language and the promotion of the linguistic identity of the Deaf community." UNCRPD Article 2 stipulates that all languages should include signed languages while Article 21 emphasises the importance of recognising and promoting the use of sign languages. However, the EPSEN Act 2004 currently does not meet these legislative and policy objectives on the rights of Deaf people to access education through the medium of ISL. It is therefore incumbent on the EPSEN Act 2004 to include the teaching and learning of ISL and ISL as a language of instruction in school at pre-school, primary and post-primary education levels.

   Article 28 of the UNCRC says that children and young people have the right to education no matter who they are: regardless of race, gender or disability; if they're in detention, or if they're a refugee. Children and young people have the right to both primary and secondary education and should be able to choose different subjects when in secondary school. This should include the option of technical and vocational training, so they shouldn't have to focus on academic subjects if they don't want to.

2. The National Council for Special Education (NCSE) published a policy paper in 2011 which advocates for the development of bilingualism for Deaf children in Ireland, however, there has been no follow-through on its implementation. Given the importance of the ISL Act 2017 and UNCRPD (2006) on the right to access education through the medium of ISL, the IDS recommends the EPSEN Act includes a requirement for the provision of 'sign bilingual education' programmes for all Deaf children regardless of school placement. International research on sign bilingual education has been on the rise over the last twenty years to the extent that we can no longer ignore its importance in an Irish context. Sign bilingual education programmes have four main objectives, which are as follows:

   a. to promote the acquisition and use of sign language as first language to support literacy and numeracy skills in spoken language (e.g., English);
   b. to allow Deaf students to use an accessible, visual language as a means to break down access barriers and unlock the curriculum;

c. to improve deaf students' proficiency in the written and spoken language of the majority population;
d. to enhance deaf students' social, emotional, and positive identity development and their academic achievement.

The rationale for a sign bilingual education programme lies in the fact that Deaf children "are naturally predisposed to visual communication, as this mode is compatible with the way they perceive the world" and sign language is more accessible than spoken language. Evidence shows that sign language turns on Deaf people's visual abilities while spoken language requires the ability to hear and speak which Deaf people have limited use. Evidence also indicates that focus on the exclusive use of spoken language even with the support of cochlear implants has not yielded improved literacy outcomes in many Deaf children.

In 1998 the National Forum for Early Childhood Education suggested that the Department of Education investigates the potential of setting up pre-schools that provide education through sign language as well as spoken language. However, this has not been followed up on since.

3. Article 24 of UNCRPD stipulates that Governments must take appropriate measures to employ teachers fluent in sign language and professionally trained to teach Deaf children. However, there is currently no mandatory qualification for teachers working with Deaf children in mainstream school and schools for Deaf children. The situation is far from satisfactory especially when we consider the rights of Deaf children to access education through the medium of ISL and be taught by qualified and competent teachers has been upheld by UNCRPD.

   IDS suggest the EPSEN Act 2004 include a requirement for Deaf children to have access to appropriately qualified and trained teachers of the Deaf at all stages of their education and for teachers responsible for teaching Deaf children to undertake continuing professional development courses including ISL and deaf awareness courses. It is also the case that teachers teaching in the Deaf schools/units are not proficient in ISL and therefore it needs to be noted that this point must be related to all Deaf students, whether they are in mainstream schools or Deaf schools.

   IDS recommends that higher education institutions specialising in teacher education liaise with the Centre for Deaf Studies, Trinity College Dublin, or Dublin City University's Deaf Education training program to develop modules on ISL teaching and learning and Deaf Studies for inclusion as part of the teacher of the deaf education programme.

4. The Irish Deaf Society believes that individual education plans for Deaf children, under section 8 of the EPSEN Act, should include a specific focus on the development of ISL skills and access to appropriate communication supports. It is crucial that the plan is developed in consultation with a Deaf education specialist who has a thorough understanding of the unique needs of Deaf children.

5. Section 9 of the Act highlights the role of Special Educational Needs Organisers (SENO) in the education of children with special needs. The Irish Deaf Society believes that SENOs should be required to have expertise in Deaf education and ISL to adequately support Deaf children and

their families. This expertise should include knowledge of the various communication modes available to Deaf children, such as ISL and other sign languages, as well as a deep understanding of the social and emotional needs of Deaf children.

6. Early language acquisition of Irish Sign Language is critical for Deaf children as it gives them a solid foundation for future learning and socialisation. Without this early intervention, Deaf children suffer from language deprivation which can significantly affect the development and well-being of deaf children.

   Some benefits that Deaf children can earn from early language acquisition are as follows:

   a. Improved cognitive development: Language acquisition supports the development of cognitive skills, such as memory, attention, and problem-solving, which can benefit a child's overall learning and academic success.
   b. Better communication skills: Early language acquisition can help Deaf children develop effective communication skills, which can help them build relationships with others and effectively communicate their needs and thoughts.
   c. Increased socialisation opportunities: Early language acquisition can help Deaf children interact with their peers and adults, which can help them develop social skills and build connections with others.
   d. Higher self-esteem: Early language acquisition can help Deaf children feel more confident and comfortable expressing themselves, improving their self-esteem and overall well-being.
   e. Improved literacy skills: Early language acquisition can support the development of literacy skills, which can help Deaf children succeed academically and in their future careers.
   f. Overall, early language acquisition of ISL is critical for Deaf children as it can provide them with a strong foundation for future learning and socialisation.

7. The European Union of the Deaf supports mainstream education for Deaf students, providing it has specific conditions met that would make it compatible with the UN Convention on the Rights of Persons with Disabilities Article 24. Mainstream Education is not proven successful for Deaf children, with Deaf students in being placed at a serious disadvantage. Krausneker et al (2022) state mainstream schools in most European countries struggle to maintain quality education in sign languages for deaf children.

   The conditions that must be met are as follows:

   a. Acceptance that mainstream schools apply equally to a teacher and the Deaf child and must involve the integration of hearing children and interpreters together.
   b. The Deaf child must have functional access to the school curriculum
   c. Parents, teachers, and hearing children must learn Irish Sign Language
   d. Schools must have Deaf teachers
   e. Research must be carried out into the effects of integration and its continual monitoring

8. The need for accurate assessment and monitoring of the educational progress of Deaf students needs to be considered. Regular data should be collected and reported on regarding the educational outcomes of these students. This will help to identify any areas of concern and inform the development of policies and programs to better support these students in the future. It is also important that accurate data is collected regarding the usage of ISL in education.

9. The majority of Deaf children are born to hearing parents, many of whom have no previous experience or knowledge of the Deaf community. DCU's Elizabeth Mathews report from 2021, 'Socio-Emotional Development in Deaf and Hard of Hearing Children', found that only one family out of 20 families who have a Deaf child was given any information about ISL or the Deaf community. Parents need to be supported by organisations such as the IDS, as well as the Department of Education in ensuring that they are aware of their children's right to Education in their preferred language. The Department currently provides the Visiting Teacher Service, which claims to support ISL provision, however, spoken language remains dominant over ISL. Visiting teachers must be further informed and aware of ISL and the Deaf community to be able to support family members to the full extent. It is also important that family members have access to ISL. For Deaf parents of students, the Department of Education needs a clear policy regarding the provision of access and information through ISL. Many Deaf children who have cochlear implants, or other hearing aids, are not encouraged to use ISL, or their families are not provided with information about the Deaf community.

10. Many Deaf students are currently supported by Deaf Special Needs Assistants in their classrooms. However, the title of SNA is not sufficient to cover the job that these members of staff are doing. A more appropriate title for such roles is needed, as a huge percentage of their day-to-day tasks is to interpret and ensure that student is following what is being discussed in the classroom.

    The Department of Education must make a conscious effort to employ Deaf people in schools that have Deaf students. Seeing successful Deaf people can inspire and motivate students to pursue their own aspirations. Deaf role models can also provide invaluable guidance and support and exposure to a diverse range of Deaf role models can help students develop a positive sense of identity and pride in their Deaf culture and community. By providing access to Deaf role models, the Department of Education can create a more inclusive and empowering learning environment for Deaf students.

11. Having Irish Sign Language on the school curriculum is crucial for the full inclusion and equal education of Deaf people. For hearing students, learning ISL is extremely beneficial as it can help promote greater awareness and understanding of Deaf culture and community, as well as fostering empathy and respect for linguistic and cultural diversity. IDS propose that the EPSEN Act 2004 include a requirement for the inclusion of ISL as a compulsory subject in school and an exam subject at Junior and Leaving Certificate levels.

12. The National Council for Special Education has an Irish Sign Language Scheme in place, however the scheme falls far short of the World Federation of the Deaf (WFD) position that inclusive education for Deaf learners is that of high-quality education with direct instruction in sign

language, access to Deaf teachers and Deaf peers who use sign language, and a bilingual curriculum that includes the study of sign language. The IDS recently made a submission to the NCSE outlining our view on this scheme – that submission has been attached to this document. The submission expresses that the IDS strongly disagree with the medical criteria, which suggest that ISL should be available only to those who are profoundly Deaf and without Cochlear implants.

13. The Department of Education is responsible for the implementation of the ISL Tuition scheme. We have sent a proposal for reform of that service to the Department and received no response. The IDS Deaf Education position paper calls for improvements to this scheme which is currently not delivering enough.

14. The use of appropriate technology, such as captioning, real-time translation and assistive listening devices should be used where appropriate to support Deaf students who may not use ISL in the classroom and ensure equal access to educational material.

15. Consultation in relation to Deaf education and students must be sought from Deaf experts in this area. As outlined under the UNCRPD, disabled people and our representative organisations must be consulted on all decisions which impact our lives, not just on legislation specifically focussing on disability. The UNCRPD also states that DPOs must be involved in consultation processes from the planning or design stage onwards.

Conclusion

The Irish Sign Language Act 2017 recognizes Irish Sign Language (ISL) as the indigenous language used by the Deaf community in Ireland. This act acknowledges the right of Deaf people to use ISL as their native language and obligates public bodies to provide information and resources through ISL. The United Nations Convention on the Rights of Persons with Disabilities strengthens this emphasis on the rights of Deaf people to access education through the medium of ISL.

Sign bilingual education programs have four main objectives, including promoting the acquisition and use of sign language as a first language to enhance the social, emotional, and positive identity development of Deaf students.

The Irish Deaf Society believes that individual education plans for Deaf children should include a specific focus on the development of ISL skills and access to appropriate communication supports. Additionally, they recommend that higher education institutions specializing in teacher education develop modules on ISL teaching and learning for inclusion as part of the teacher of the deaf education program.

Overall, the IDS emphasizes the importance of early language acquisition of ISL for Deaf children and highlights the need for qualified teachers and appropriate access and support to fulfil their right to education.

Supporting Documents

1. Irish Sign Language Act 2017:

   https://www.irishstatutebook.ie/eli/2017/act/40/enacted/en/html

2. Deaf Education position paper:

   https://www.irishdeafsociety.ie/about/policy-paper-deaf-education/

3. The Education of Deaf and Hard of Hearing Children in Ireland – NCSE Policy paper:

   https://ncse.ie/wp-content/uploads/2014/09/DeafEducationReport.pdf

4. Socio-Emotional Development in Deaf and Hard of Hearing Children:

   https://www.chime.ie/images/uploads/news/Socio-Emotional_Development_in_Deaf_and_Hard_of_Hearing_Children_2021.pdf

5. IDS NCSE Submission:

   (Attached to email submission.)

6. Bilingual School Education with Spoken and Signed Languages in Europe:

https://www.tandfonline.com/doi/epdf/10.1080/13670050.2020.1799325?needAccess=true&role=button

7. The Case for Sign Bilingualism in Irish Deaf Education:

   https://journal.iraal.ie/index.php/teanga/article/view/1275/1622

For further information regarding the information stated above, please contact the Irish Deaf Society Advocacy Service at advocacy@irishdeafsociety.ie or 01 860 1878.