

STEM Education

Consultation Report 2017





TABLE OF CONTENTS

Introduction	2
The Consultation Process.....	3
School Consultations.....	4
Format of School Focus Groups.....	4
Emerging Themes	5
Stakeholder Consultation.....	8
Format of Stakeholder Consultation	9
Feedback on STEM Report Themes	10
STEM Education Online Consultation	12
STEM Education Online Response	12
Emerging Themes	12
Key Observations from the Consultation	19
Appendix 1: Towards a STEM Education Policy Statement for Schools	21
Background	21
Consultation on Implementation	21
The Consultation Process.....	24
Appendix 2: STEM Education Stakeholder Consultation	25



Figure 1: Parent Focus Group



INTRODUCTION

In the development of a *STEM Education Policy Statement* (Policy Statement) and Implementation Plan, a series of STEM education consultations were undertaken between May and July 2017. These were conducted to gather the views and opinions of key stakeholders to inform the Policy Statement. The development of the Policy Statement was initiated as a result of the *STEM Education in the Irish School System Report*¹ (the STEM report) published by the STEM Education Review Group. The STEM report stated that the Department of Education and Skills (the Department) should:

Produce an integrated National STEM Education Policy Statement with input from, and relevance to, all stakeholders across the continuum of education in Ireland (primary, secondary and third level). This Policy Statement should include a detailed implementation plan with responsibilities and timelines clearly outlined.

The Minister for Education and Skills Richard Bruton T.D. prioritised 21 of the 47 recommendations from the STEM report. At the launch of the report² on 24th November 2017, a commitment was made to implement the 21 prioritised recommendations. Subsequently, the Department developed a Consultation Paper, *Towards a STEM Education Policy Statement for Schools* (Appendix 1) which informed the consultation process.

The consultation process focused on the recommendations associated with the six themes that were outlined in the STEM Report.

- Theme 1:** Preparation of Teachers for STEM education in Ireland
- Theme 2:** Supporting STEM Teachers within the system (with a particular focus on CPD)
- Theme 3:** The introduction of new teaching and learning modalities that would enhance STEM education in our schools and for which there is a strong evidence base.
- Theme 4:** The use of technology to enhance STEM learning
- Theme 5:** The promotion of STEM careers and the identification of methods to enhance the engagement of students in STEM subjects
- Theme 6:** Conclusions and general recommendations proposed in the STEM Report

The STEM education consultation was facilitated by Dr. Michael Hallissy and John Hurley of H2 Learning³ and they were supported by Cyril Drury who provided analytical assistance on the online survey data. H2 Learning also worked with the Department of Education and Skills on the development of the STEM Education Policy Statement and Implementation Plan.

¹ STEM Education in the Irish School System Report, <https://www.education.ie/en/Publications/Education-Reports/STEM-Education-in-the-Irish-School-System.pdf>

² Minister Bruton launches the Report of the STEM Education Review Group; www.education.ie/en/Press-Events/Press-Releases/2016-Press-Releases/PR2016-11-24.html

³ H2 Learning, www.h2.ie



The Consultation Process

The consultation process consisted of three distinct elements. These included:

- School focus group consultations
 - Parents/guardians (parents), young people and teachers at primary and post-primary levels
 - The school consultations commenced with the post-primary schools in May 2017 and with primary schools in June 2017.
- Stakeholder Consultation
 - Stakeholder consultation event in the Gresham Hotel, Dublin on 23rd June 2017.
- Online Consultation
 - Consultation paper *Towards a STEM Education Policy Statement for Schools*, published online.
 - Stakeholders and public invited to participate in online survey and to share their views in June 2017.



Figure 2: Participants at the STEM Education Consultation Event

All three elements of the public consultation phase focused on providing clarity around relevance, appropriate terminology, implementation issues and suggested areas for further action. The format and the structure of each of the three elements was different to reflect the different groupings and settings. The consultations were aimed at exploring the following questions:

- Were the recommendations clearly articulated and if not, how might they be further enhanced?
- Were the recommendations achievable and who needed to be involved to achieve success?
- What might success might look like in relation to the recommendations presented and were there any good examples or models that could inform their implementation?
- Were there any other areas that should be included in the STEM Education Policy Statement?

The objective was to gather sample views of young people, their parents, as well as those to be involved in the implementation of the Policy Statement.



SCHOOL CONSULTATIONS

The school focus groups took place in the following schools:

Primary

- Gaelscoil an Bhradáin Feasa, Bóthar an Mhuilinn, Droichead Átha, Co. na Mí
- St. Clare's Primary School, Harold's Cross, Dublin 6W
- St. Francis CBS, John Dillon Street, Dublin 8

Post Primary

- Maynooth Community College, Moyglare Road, Maynooth, Co. Kildare
- Maynooth Post Primary School, Moyglare Road, Maynooth, Co. Kildare
- Portlaoise Community College, Mountrath Rd, Clonroosk Little, Portlaoise, Co. Laois
- St Louis Secondary School, Monaghan Town, Co. Monaghan

There were 12 focus groups in total and these included:

- 3 focus groups with primary school pupils
- 3 focus groups with post-primary students
- 3 focus groups with primary parents
- 1 focus group with post-primary parents
- 2 focus groups with primary teachers

Format of School Focus Groups

A focus-group methodology was used to gather the views of all three stakeholder groups with a mix of written and oral feedback provided on the questions posed.

The school consultations focused primarily on 3 themes:

- Theme 3:** The introduction of new teaching and learning modalities that would enhance STEM education in our schools and for which there is a strong evidence base.
- Theme 4:** The use of technology to enhance STEM learning.
- Theme 5:** The promotion of STEM careers and the identification of methods to enhance the engagement of students in STEM subjects.

The views of young people, parents and teachers were sought in relation to issues such as:

- Their understanding of STEM
- How young people engage with STEM in their daily lives
- How STEM knowledge and understanding can be developed both within and outside of school
- How the education system can better support STEM learning in schools and outside
- How the education system can better inform all stakeholders of the opportunities that engaging with STEM can provide



Emerging Themes

The consultations indicated that STEM is an important topic in schools, particularly to parents. They are aware that their children are growing up in a digital global economy, where STEM related skills are essential to be an active citizen and to contribute to the economy.

Young People

The consultation process generated discussion among the young people and each group provided valuable insights into what STEM meant to them. The young people (particularly the post-primary students) had lots to say about STEM and in particular how they like to develop their STEM skills.

Table 1: Key Observations of Young People

Key Observations of Young People
The young people's responses highlighted that there was some ambiguity around what STEM meant to them. Though they all understood the acronym, there was much discussion and debate about what constituted STEM subjects and STEM careers.
They enjoy participating in projects outside of school including SciFest, CoderDojo and Discover Primary Science and Maths, where they become immersed in the activity and often forget they are learning.
Young people are keen to engage with STEM as early as possible in their school lives and they want to have practical experiences, moving beyond learning from books.
They would like more information on how the subjects they are taking can help them pursue careers in STEM when they leave school. For example, to be a designer they would like guidance on which STEM subjects could help them achieve this.
They want to enjoy their STEM learning, to understand the STEM concepts they encounter in school and move beyond just learning facts. They want to participate in 'Hard Fun'.
They enjoy engaging in STEM learning when they are active and learning from their mistakes.

The young people were very aware that STEM is all around in their daily lives and they are curious to know how they can better use their STEM knowledge to solve problems in the world. Many post-primary learners spoke about engaged and committed teachers who had sparked their interest in STEM and they were seeking similar experiences in the future.



Figure 3: Primary pupils list activities they associate with STEM



Teachers

Teachers are keen to develop the STEM competence of their learners and they are seeking greater guidance and support in this regard. Primary teachers believe they are predominantly teaching Maths and Science and they often find Engineering and Technology more challenging. They would like assistance as to what an integrated STEM teaching approach might look like, where they are teaching STEM in a cross-disciplinary manner. They asked questions such as “*Where does the engineering fit in?*” and they were keen to learn how they could use STEM approaches, such as problem-based learning, to support their learners.

Teachers recognise the need to equip our young people with a strong STEM foundation and they would like opportunities to participate in quality hands-on professional learning activities. Teachers see great value in programmes, such as Discover Primary Science and Maths, and they want more assistance to embed STEM into their classroom teaching. This would include additional supports such as access to learning activities, projects they can participate in, and STEM resources that engage young people.

Table 2: Key Observations of Teachers

Key Observations of Teachers
Teachers are particularly interested in using projects and an inquiry-based approach to teach STEM subjects.
Teachers mentioned that project work often is more time consuming and they fear they will not ‘cover’ the curriculum, hence a reluctance to overly engage in projects.
They want guidance on how they might integrate STEM across the curriculum and in particular guidance on sample activities they might use with their learners.
They want access to examples of teacher practice in relation to STEM, so they can see how other teachers use certain resources to design engaging learning activities. Ideally these could be captured and shared online.
Many feel they are only teaching Science and Maths, while Engineering and Technology is more difficult to teach. They would like help in this area.
Teachers would like more practical and hands-on professional learning experiences, so they can design and embed STEM learning activities in a more cross- disciplinary way.
Teachers have observed how STEM projects can provide opportunities for cross-disciplinary learning and they want more help to engage in such activities.

Parents

Parents were extremely positive about STEM and the need for their children to have access to a quality STEM education. Parents of primary school children observe the inquisitive nature of their children and their interest in engaging STEM learning activities and they would like to see more of this taking place, both within and outside of school. Parents (particularly at post-primary) see great value in young people engaging in STEM project work where they can develop skills such as resilience, perseverance, teamwork, communication and much more. Parents would like to see availability of more out-of-school STEM learning experiences.

Parents view STEM education as an enabler of skills that their children will require for the future, irrespective of their chosen career path. They are also very aware of the importance of young people studying STEM subjects and would like more opportunities for young people to ‘*try out*’ these subjects, so they can make



informed choices. They believe that STEM subjects are often perceived as being difficult and time-consuming and they question if the time spent on such subjects is justified. Parents, particularly of girls, would like to see more female STEM teachers and more choice for their children.

Table 3: Key Observations of Parents

Key Observations of Parents
Parents are generally positive and enthusiastic about their children developing an understanding and a love of STEM.
Parents recognise that STEM is all around us and that we need to prepare their children to be critical thinkers and to have opportunities to ask questions about the world in which they live.
Parents would like schools to provide opportunities to sample STEM subjects in post-primary, before they make their final decisions on subject choice.
Parents of primary pupils have observed how engaged and inquisitive their children can become with elements of STEM, whether it is using Lego to construct models or using technology such as Minecraft to build 3D worlds and they want to see more of this type of active learning.
The parents of the post-primary students expressed concern that certain STEM subjects can take up a lot of time, e.g. higher-level Mathematics, and that their children can have difficulty with them.
Parents feel that all young people need a basic understanding of STEM, even if they don't go on to study it in third level or to work in STEM careers.
Parents feel that girls have limited choices in STEM related subjects and would like to see more subject choice for their daughters and more female STEM teachers.
Parents value the participation of their children in out-of-school STEM projects. They see these activities as providing opportunities to develop key skills such as teamwork, social skills, communication, experimentation, leadership and can ultimately inform career choices.
Parents would like to see former students who have studied STEM subjects, or who are working in STEM careers, returning to their schools and sharing their perspectives.



Figure 4: Primary Parent Focus Group



Conclusions

The consultations support many of the key findings from the STEM Report. Young people are keen to engage in STEM learning where they are active and are afforded practical opportunities to develop their knowledge and understanding. Teachers welcome the opportunity to develop STEM understanding through inquiry-based learning approaches, but they would like further assistance in this area. Parents are acutely aware that the jobs of the future will be dependent on STEM related skills and they want their children to have a wide range of opportunities of engaging with STEM throughout their school careers.

The focus groups of teachers highlighted the challenge of implementing STEM education using a cross-curricular approach, so that all strands of STEM are included because many people tend to think of individual STEM disciplines rather than in a cross-curricular way. Teachers indicated that they would need support to teach using a cross-disciplinary approach. Teachers, parents and young people are positively disposed to STEM and welcome the creation of a STEM Education Policy Statement and hope that it will support them and their learners in the future.



Figure 5: Post-Primary Parent Focus Group



STAKEHOLDER CONSULTATION

A STEM stakeholder consultation was held on Tuesday 13th June 2017 in the Gresham Hotel, Dublin. A total of 80 participants took part in the consultation with attendees representing:

- Initial Teacher Education
- Third Level Research
- Teacher Unions and Representative Bodies
- DES and Support Services
- Other Government Departments
- STEM Industry



Figure 6: Group discussion at Stakeholder Consultation

Format of Stakeholder Consultation

Participants considered the actions contained in the Consultation Paper, *Towards a STEM Education Policy Statement for Schools*, and how these might be implemented in the system. Those in attendance discussed the actions associated with each of the six themes and considered how best to implement them in the future.

They were asked to consider:

- What are the implementation priorities required for these actions?
- Is there anything missing?
- Who needs to be involved?
- Are you aware of any examples where this or similar actions have worked well?

The discussions were wide ranging and touched on issues such as teacher selection, teacher preparation, STEM curriculum, prevailing STEM mindsets, STEM careers, and the role of business and industry in supporting STEM.



Feedback on STEM Report Themes

Each of the six themes highlighted their own unique set of observations and these are captured below.

Theme 1: Preparation of Teachers for STEM education in Ireland

Feedback from the consultations indicated that Initial Teacher Education (ITE) is diverse and that there is no one-size-fits-all approach to preparing teachers for STEM education. There are particular issues at primary in relation to teachers' confidence and conceptual understanding of STEM education. At post-primary, the teacher shortage issue in disciplines such as Physics and Chemistry was raised. The need for research on what constitutes good practice in STEM education was a repeated message. It was noted that STEM education starts at Early Childhood and that there needs to be closer linkages across the continuum to post-primary. There was a strong view that STEM education should support collaborative learning approaches where learners are actively engaged in developing deep conceptual understanding.

Theme 2: Supporting STEM Teachers within the system (with a particular focus on CPD)

There was agreement that teachers within the system require a range of supports to help them implement STEM education. The discussions captured the pressures on teachers to find time to participate in quality professional learning activities. Many called for a new model of professional learning for STEM education, one that is cross-disciplinary, project-based and promotes collaboration and sharing of practice among teachers. Those in attendance supported a model of professional learning that afforded teachers choice in terms of engaging in accredited or non-accredited CPD. People want a wider choice in terms of CPD offerings. There was a recognition that this is an opportunity to design and offer new models of professional learning for teachers in this area.

Theme 3: The introduction of new teaching and learning modalities that would enhance STEM education in our schools and for which there is a strong evidence base. Theme 4: The use of technology to enhance STEM learning (combined).

Participants considered the actions associated with themes 3 and 4 and many of the discussions mentioned Science and the need for more focus on Science at primary level. There was a strong view that there needs to be a focus on developing STEM concepts through cross-curricular, authentic, real world examples. We should provide young people with learning opportunities to engage in STEM investigations rather than practical work. In addition, the view was shared that digital technology should be embedded in STEM learning and not seen as an add-on.

Theme 5: The promotion of STEM careers and the identification of methods to enhance the engagement of students in STEM subjects

Views were expressed that STEM education needs to prepare young people for STEM related careers. Young people need to see how STEM is put into practice in the real-world and how it can impact on global issues, such as climate change, food and water shortages etc. People felt there was a need to challenge stereotypes that exist in relation to STEM, including the perceived difficulty of STEM subjects and low levels of females engaging in STEM. There were suggestions around developing targeted awareness campaigns, so that learners, parents and others have up-to-date information. It was also noted that we need to engage learners in STEM from an early age and provide relevant information so that they can make informed STEM choices.



Theme 6: Conclusions and general recommendations proposed in the STEM Report

Those in attendance welcomed the concept of STEM partnerships with business and industry, but there was concern over the influence that this might have on the work of schools and people were keen to learn more about what such a partnership would entail. The idea of an ‘Excellence in STEM Teaching’ award was not well received as it was suggested it could damage cooperation and collaboration among teachers. Others pointed to existing awards, such as the SFI Discover Science and Maths Awards. There was a mixed reaction to the construct of STEAM over STEM, with some of the view that introducing another acronym could potentially cause further confusion. However, it was noted that the Arts and creativity are very much integral to the notion of STEM education and that this should be captured in the Policy Statement.

Plenary Session

A final plenary provided feedback and an opportunity to highlight examples of good practice in STEM education and any other issues that arose. Here is a sample of some of the views raised during this session.

Table 4: Key Observations of Stakeholders

Key Observations of Stakeholders
There is a need to be clear about what we mean by STEM.
Industry and jobs can't be the key driver. We want STEM for effective citizens, not just jobs.
Need to clarify the focus: is it going to be on increased uptake of STEM; increased knowledge and attitudes; creating scientific citizens who are open to evidence-based debate; or on the take up of careers?
Assessment has a heavy influence on learning in schools and we need to consider the impact of this on what happens in the classroom.
Future STEM education policy needs to address female uptake of STEM in schools. Encourage girls to become Steminists!
Shift the emphasis towards using STEM as a tool which can be used to address global and societal issues such as climate change, food security, sustainability and development.
Teachers need to be supported and provided with STEM professional learning opportunities. Team teaching is one area that could benefit the STEM classroom.
Career guidance is key to promoting STEM career options. The introduction to careers education in primary schools should be considered.
STEM business and industry have a key role to play in providing STEM education opportunities both in and outside of school.
There is a need for more Irish based research data to inform future STEM education impact.
The STEM Education Policy needs to be inclusive of all.

The event was very successful and all in attendance welcomed the chance to share their views. In addition, many of these same individuals and their organisations contributed to the online consultation phase, which is covered in the next section.



ONLINE CONSULTATION

STEM Education Online Response

The online consultation provided an opportunity for the public to respond to the Consultation Paper, *Towards a STEM Education Policy Statement for Schools*. A total of 634 distinct responses were registered via the survey link, with 583 valid responses and 218 respondents fully completing the survey. Hence the survey yielded in the region of 3,500 free text responses. The respondents came from a broad range of backgrounds and were representative of the key stakeholder groups within the education system.

Table 5: Profile of Survey Respondents

Category	Number	Percentage
School	278	43.8%
Teacher	223	35.2%
Third level	149	23.5%
Private Sector	93	14.7%
Principal	57	9.0%
Primary	50	7.9%
Other	40	6.3%
STEM Outreach	38	6.0%
Parent	10	1.6%
Education Agency	7	1.1%
Student	5	0.8%

Many of the respondents indicated their good-will towards the process and a desire to be supportive of any actions designed to enhance STEM education. From the personal data provided names, email addresses, organisational roles, it is also evident that many of the respondents have a long track record of involvement in STEM education and many expressed an interest to participate in future consultations once the Policy Statement is published. Consequently, it may be concluded that many of the opinions and perspectives captured in this survey are well informed.

Though the online questionnaire asked specific questions, many of the respondents provided additional commentary on the actions and on other STEM education matters. The quality of this commentary was generally very good, with many stakeholders providing detailed and considered responses.

Emerging Themes

Having conducted a thematic analysis of the qualitative responses the following themes were identified and a sample of the commentary is included.

1. STEM Education Implementation

The need for a STEM Education Policy

The proposed development of a STEM Education Policy Statement is understood very broadly and welcomed by stakeholders. Incorporating and successfully addressing the breadth of issues raised presents a significant challenge for policy and implementation. There is significant support and knowledge to be gained from existing stakeholders in this area and consideration should be given to how best this expertise



might be harnessed in the future. A selection of this feedback is presented below to illustrate the nature of the responses received.

Defining STEM education

One of major themes identified is the need to define the scope and breadth of the policy work. What precisely is STEM education and how are the policy priorities translated into action? The implementation of a STEM education policy needs to be accompanied by a realistic investment plan.

Education is about opening up children's and young people's minds and giving them opportunities to develop the skills and knowledge needed to do this. STEM, of course has a place in this. Without huge investment in schools and in the real professional development of teaching professionals any STEM initiative will not succeed.

(Principal Teacher)

The following statement captured a view that STEM is often reduced down to a focus on Science and Mathematics and that Technology and Engineering are lost. This was a salient reminder that the policy will need to provide clarity on what is meant by STEM.

Throughout this questionnaire the focus of the action points seemed to lie on the science element of STEM. It is important to ensure that the remaining aspects of STEM are given equal focus. There are also quite a number of groups, professional bodies, educational institutes where there are a large number of people who have significant expertise in the area and who may be willing to work to further the success of this policy statement.

(Institute of Technology Lecturer and Engineering Professional)

Build on existing good practice and research

Many contributors believed that there is significant good practice already happening in schools and this combined with the expertise of the Irish educational research community, should help to inform any new interventions. The need to share existing examples of good professional practice in STEM education was also raised.

Many responses referenced the need for the implementations of actions to be informed by research. Respondents suggested examples of initiatives, some overseas but the majority within Ireland that they believe are relevant in terms of informing the proposed actions. Another recurring view was that any new actions must seek to build on already existing networks and expertise to ensure maximum benefit for the system as a whole.

There is a lot of work ongoing across the country at third level institutes and in research centres in relation to STEM teaching and learning. The aim of all projects is to improve students' and teachers' levels of competency in all STEM disciplines. This work includes research, CPD provision, ITE initiatives and outreach. Some kind of platform needs to be established so that a directory of ongoing projects can be recorded.

(Lecturer in Mathematics Education)

Please work with schools of education on this important issue....We have extensive contacts with the research community and can point to best practice in other countries.

(University Lecturer in Science Education)



Investment will be needed

Many submissions noted that investment in broadband, quality digital technology and STEM resources will be required. Others highlighted the loss of posts of responsibility and initiative overload in schools as issues that could impact negatively on the policy. There was a strong message that investment will be required to successfully implement STEM education both in and outside of school.

If serious, then it should receive realistic funding. Without significant funding any such initiative, no matter how well designed will fail.

(Post-primary teacher)

Planned partnership with business and industry

While collaboration with business and industry was welcomed, there was some concern about opening schools up to excessive commercial influence and bias. It was suggested that any partnerships with the private sector would require careful planning.

More links need to be forged between education institutes and industry. It needs to be more than a one day a year PR event. Perhaps providing a tax incentive scheme, more companies will be available to give back to schools.

(Engineer)

As many schools already do engage with STEM industries, an audit of current practices and an evaluation of its effectiveness from the perspective of teachers, students and industry should be carried out before further investment is committed.

(Lecturer in Institute of Technology)

2. Curriculum

The following themes emerged relating to curriculum issues.

STEM education as one component of a broad education

Responses indicated a need to ensure that STEM does not dilute the existing curriculum but strengthens a cross-curricular approach that prepares our young people for living and working in the 21st century.

STEM is not a subject that sits alone. It's a part of all of our everyday lives. If we can build a STEM curriculum around this, maybe we stand a chance of delivering.

(Insurance Company Executive)

This appears to be very ambitious and will hopefully not be to the detriment of the existing curriculum. Without the foundations in maths and science all will be lost. In the incorrect hands some of this sounds as if some of these approaches, which should be there to support the curriculum, will replace parts of the existing curriculum.

(Director, Social Enterprise providing STEAM education)



STEM subjects versus cross-disciplinary approach

The Policy Statement needs to consider all aspects of STEM, particularly the Technology and Engineering subjects, and ensure they are fit for purpose.

I believe the report on STEM education in Ireland very much glossed over the current practice that is ongoing in the subjects of Technology, Engineering, DCG and Construction Studies. There are large cohorts of students partaking in these subjects in schools around the country and there is great effort amongst teachers of these subjects to really educate students in the area of STEM.

(Teacher)

It is very disheartening as a Practical teacher to have my subjects which form 50% of the STEM title completely ignored time after time....my subjects are constantly marginalized and ignored when talking about STEM.

(IT Co-ordinator and Engineering teacher)

Linking the Arts with STEM

There is a need to ensure that the Policy Statement recognises the strong linkage between STEM and Arts education which fosters design, creativity and innovation.

I disagree that the policy statement should include arts. However, I think that those students that are talented in arts, languages etc. rather than STEM based subjects should be embraced for their own abilities and not overlooked.

(Executive, multinational company)

The need for a more creative pedagogy

STEM education needs to promote active learning and a focus on cross-disciplinary approaches. Responses indicated a need for support in reframing the curriculum, moving away from subject specifications that are overly reliant on extensive content, and instead incorporating a more skills-based curriculum with space for active learning and problem-based learning strategies. However, concerns were expressed that changes must not be at the expense of existing system strengths, and that we continue to provide a pathway for producing high quality STEM graduates.

Design thinking is absolutely essential to STEM recruitment and development but it is under recognised in this survey.

(Lecturer, Multidisciplinary Technologies)

There are many good examples of effective STEM education pedagogy and learning resources being used across all levels of education in Ireland. However, these tend to be isolated and not systemic. The PDST have produced effective resources for teachers in the STEM area but the engagement seems to be low.

(Lecturer in Institute of Technology)



3. Infrastructure

Observations made in relation to infrastructure included the need for investment in STEM education, both in terms of people and resources.

The requirement for a high-quality infrastructure in all schools

Positive responses were returned regarding the uses of ICT in STEM education but also indicated that some schools would be at a serious disadvantage because of poor local access to high speed broadband and access to suitable ICT infrastructure. Funding to maintain their existing ICT infrastructure and procure new equipment and STEM resources was highlighted.

A lot of the themes stated are aspirational and simply impossible without significant investment in school infrastructure both hardware and software, technical support, maintenance and security before you start on the training and upskilling.

(Lecturer, Institute of Technology)

There is a huge discrepancy across schools regarding their access to the basics such as a good stable infrastructure such as broadband, network and access to devices (desktop, laptops, tablets).

(Lecturer, Institute of Technology)

4. Teaching Capacity

Initial Teacher Education as central to STEM education

Feedback in this area highlighted the need to recruit more people to the teaching profession, at all levels, with well developed STEM competences.

As regards ITE, I think much more time and focus on STEM content (in addition to pedagogy) is critical to STEM education. You cannot effectively teach what you don't understand - and so spending time on addressing that aspect is key to success.

(Director, Social Enterprise)

Need to establish baseline levels of qualifications for ITE (primary) teachers....Mandatory study of STEM subjects for trainee teachers and upscaling for existing teachers.

(University Lecturer)

The STEM teaching profession should move towards a masters entry profession and this should be funded, whether done through a 2 year PDE course or 5 year concurrent course. There should also be more control of numbers of trainee second-level science teachers in relation to the number and type of jobs available, in order to raise the quality of the profession.

(Director of Education Research group)

The need to upskill the current cohort of teachers

The need to provide a range of supports, including professional learning opportunities and resources, to assist teachers in developing their confidence and knowledge of STEM education was reported as an issue.



The current cohort of Primary Teachers who've had absolutely NO science education in their life to date, many of whom will be in classrooms for a long time before they retire, are a niche group that need to be addressed.

(Teacher and PhD Researcher)

Teachers should have access to up-to-date web-based materials that they can share with their students around the appliance of STEM and career possibilities in STEM... and they should include interactive activities for the students.

(Educational Policy and Research Officer)

Reflective practices (needed) whereby student teachers are conscious of areas for improvement... I would suggest that pedagogical content knowledge also be included as well as technical skills and disposition.

(Lecturer in Science Education)

STEM teacher mentors in schools

Respondents saw a need for STEM to be championed in schools but there were varied views as to how best to achieve this. Some felt that this responsibility is best shared rather than invested in one individual.

I have found that the focus on Technology enhanced learning is normally down to one or more passionate teachers. These teachers must be supported through CPD etc. It is also imperative to encourage more teachers to engage in integrating technology into teaching and learning... Teachers engaged in teaching these subjects must be supported through ongoing, meaningful CPD and a network of supportive skilled practitioners to enable them to excel and to provide the best experience for their students.

(Institute of Technology Lecturer involved in schools outreach)

I don't feel that 'stem champions' should necessarily be people with masters degrees. There are lots of 'champions' who are very dedicated, driven, experienced and believe in the process who don't have these qualifications in primary ed. Don't like the term 'stem champion' either.

(Primary Teacher)

5. Diversity & Inclusion

Respondents the need for STEM education to be available to all young people and that the Policy Statement should reflect the diversity of learners in our schools.

Strategic interventions

The need to ensure that all young people are afforded quality STEM learning experiences from Early Years through to Leaving Certificate Level was highlighted. This would require a wide range of supports for schools so that the maximum number of learners have an opportunity to actively participate in a quality STEM education. Issues of equity and inclusion were raised throughout the survey, particularly in the context of smaller and rural schools. Social disadvantage was also cited as a reason for schools losing out because of fewer opportunities to build partnerships locally.



I feel that inclusion and educational disadvantage should be specifically referred to and given special priority within any STEM policy.

(Primary Teacher & Masters student)

Focus on parental education; focus on early years experiences; focus on the psychology of attitude formation.

(Director of Clinical Psychology)

Consider all the issues in STEM education particularly diversity and inclusion. Link attendance and participation with organisation such as WITS as part of that non-traditional CPD for STEM teachers.

(Women in Technology and Science)

Supports required to encourage more female participation in STEM

Concerns around gender and STEM were widely expressed. A significant number of respondents identified the need for high profile role models and enhanced access to STEM subject options within single sex schools. Some respondents noted that equitable female take-up of STEM subjects was a universal concern and was not readily solvable.

As the mother of two girls attending an all girls school it is my experience that there is very little experience or encouragement given to possible careers in engineering. Very little guidance given around subject choices. Much falls back to the parents which is fine if the parent is aware of the opportunities that are available, not the case if the parent(s) have no insight into the matter.

(Executive, multinational company)

I feel very strongly that the lack of interest in STEM by girls starts at a very young age, and that, until we implement education which takes account of gender, we will not solve this. We cannot resource jobs/growth in STEM at the moment, yet, about 80% of girls are not considering STEM as a third-level option. This is a very much untapped resource, and we need to take action quickly... I also feel strongly that gender-focused training should be included for teachers. There are far too many examples of where girls are discouraged from taking STEM subjects, even though we know we have a resource crisis for STEM jobs.

(University Researcher)

Increasing female participation and challenging gender stereotypes must be a central element of the proposed changes. To this end addressing the significant craft-based focus of technology subjects and their masculine image will be important.

(Head of a University School of Education)

KEY OBSERVATIONS FROM THE CONSULTATION

The consultation has allowed a range of stakeholders to provide constructive feedback to inform the development of the STEM Education Policy Statement. The process has highlighted the need for a number of the recommendations to be further clarified and key observations arising from the consultations are identified below

What is STEM?

- The consultation with learners, parents and teachers established that there were some misconceptions around the definition of STEM. The consultations clarified the need to define what we mean by STEM education, as this is key to avoid confusion and ambiguity in the Policy Statement. Much of the discussion with stakeholders focused on issues associated with the focus on Science and Mathematics to the exclusion of Technology and Engineering.
- Teachers, learners and parents think in terms of subjects and the consultation identified the need to link STEM to existing curricula. The consultation also highlighted the need for a balance between STEM subjects and a cross-disciplinary approach to STEM.
- The consultation considered the use of the acronym *STEM* versus *STEAM*. While most respondents believe that creativity and design are essential to a quality STEM Education there was limited support for using the term *STEAM*. Many felt that it should be an underlying principle.
- Parents would like their children to experience a wide range of STEM related subjects, either in primary or in the early part of post-primary so they can make informed subject choices.



Figure 7: Primary pupils work on mind-map to illustrate their understanding of STEM

Investment

- The consultation highlighted the need for the Department to resource STEM education, both in terms of infrastructure and human capital investment.
- A number of ongoing STEM initiatives funded by various government departments and the private sector have been identified and a coordinated approach will be required to provide a comprehensive STEM experience for learners both inside and out-of-school.
- Participants highlighted the need for STEM professional learning opportunities. Incentives may be required to encourage participation in additional CPD
- Investment across all levels of the continuum of teacher education will be required in order to provide qualified and competent teachers who are confident and knowledgeable to teach STEM.

STEM and Wider Society

- The overarching view was that we need a STEM educated society where young people are equipped with the knowledge and skills to engage in informed debate around issues that concern them and society at large.
- The consultation process also highlighted that young people often focus on STEM related professional careers, such as nursing or engineering, with less focus on vocational STEM related careers such as plumbing, electrician etc. There is a need for more information to be provided on the diversity of STEM careers and the multiple progression routes into STEM careers.



Figure 8: Post-primary students identify subjects they associate with STEM

APPENDIX 1: Towards a STEM Education Policy Statement for Schools



Background

The Department of Education and Skills is engaging in consultation with stakeholders to develop and implement a STEM Education Policy Statement for Schools, hence referred to as the STEM Policy Statement. The Department's work in this area is being informed by the STEM Education in the Irish School System report⁴, hence referred to as the STEM Report, which was published by the STEM Education Review Group in November 2016. This report drew upon the expertise of many individuals and organisations and involved significant consultation with a broad range of stakeholders. The STEM Education Review Group's Terms of References focused on *five* issues across Primary and Post-Primary education:

1. The preparation of teachers (at 1st and 2nd Level) for STEM education (so-called Initial Teacher Education).
2. The best methods of supporting the current cohort of STEM Teachers already in the system, with a particular focus on Continuing Professional Development.
3. The introduction of new teaching and learning modalities that would enhance STEM education.
4. The use of digital technologies to enhance learning.
5. The promotion of STEM careers and methods to enhance the engagement of students in STEM subjects.

The Minister of Education and Skills has accepted the Report and the Minister has prioritised 21 of the 47 actions identified. These actions will inform the creation of a new STEM Policy Statement, which the DES is currently developing. The STEM Report was commissioned by the DES to ensure the continuous development of a pipeline of talent to support both Foreign Direct Investment (FDI) and an active ecosystem for indigenous start-ups. The promotion of STEM within our education system is a key priority for the DES and is reflected in multiple strategy documents, such as the Action Plan for Education, the National Skills Strategy and the Digital Strategy for Schools.

The DES is already actively engaged in promoting STEM across the education system through the updating of existing STEM curricula and in working with outside organisations to promote STEM among all learners. In tandem with the STEM Report, the DES and our relevant agencies have reviewed a range of STEM policy statement and implementation programmes in other countries. Furthermore, the STEM Report has highlighted a range of additional actions that could also be included in our new STEM Strategy Policy and the DES wishes to consult with partners on these actions, with a view to creating a world class STEM Strategy Policy statement for Ireland.

Consultation on Implementation

In developing our STEM Strategy Policy, the DES is undertaking a range of consultations to gather stakeholder views on a number of proposed actions to inform how best these might best be implemented within the system. While the DES recognises that much work is already underway in the system to enhance the uptake of STEM we are keen to gather the views of our stakeholders in shaping our new STEM Strategy Policy.

⁴ STEM Education in the Irish School System Report, <https://www.education.ie/en/Publications/Education-Reports/STEM-Education-in-the-Irish-School-System.pdf>



We would invite you to review the following statements and consider the questions we have posed in relation to each.

Theme 1: Preparation of Teachers for STEM education in Ireland

The following actions are designed to enhance the knowledge and practice of all teachers entering initial teacher education programmes, so we attract more students who have taken STEM subjects to a high level in to the profession, while also deepening the STEM knowledge of all preparing to become teachers.

Consider how the following actions could improve the preparation of teachers for STEM education.


1. The ongoing supply of ‘qualified STEM teachers’ (at post-primary level) should be a particular focus of the Teaching Council in its planned report on teacher supply to the Minister for Education and Skills.
2. Consider the following actions in relation to ITE and how they might improve teacher preparation:
 - i) Students of ITE (primary) programmes should undergo an audit of subject-matter knowledge (SMK) in STEM subjects (mathematics and science) over the course of their programme. Self or peer-evaluation may be helpful in this regard.
 - ii) Require all primary teachers in ITE to pass all STEM-methodology-related subjects (without compensation) in final examinations, where this is not currently the case.
 - iii) Include a formal consideration of STEM education during mentoring of student teachers during their primary school placement.
3. The development of specialist STEM teachers (‘STEM Champions’) should be encouraged in primary schools. Such specialists would work with colleagues to disseminate insights and best practice in STEM Education. A ‘STEM Champion’ should hold a recognised postgraduate qualification (e.g. in Mathematics Education, Science Education, Technology Education, STEM Education). Support should be provided to primary teachers to gain such qualifications.
4. Support the active engagement of schools with STEM-related industries across a broad range of fronts (e.g. the possibility of optional placements in STEM industries during primary and post-primary teacher preparation phases should be explored).

Theme 2: Supporting STEM Teachers within the system (with a particular focus on CPD)

The following actions are designed to enhance the quality of those within the teaching profession, so they can constantly enhance their professional STEM practice and knowledge throughout their careers.

Consider how the following actions could improve how we support teacher professionalism within the system:

1. Support STEM teachers (primary and post-primary) financially and through appropriate career opportunities to embrace CPD and lifelong learning in their STEM disciplines (and related pedagogy) as a means of advancing their professional development.
2. Develop a common currency for assessing and accumulating CPD elements in STEM education for accreditation purposes. Such currency units (such as credits or points) should be used in defining professional recognition from the Teaching Council.
3. Link formal and informal STEM education providers under a national initiative, such as SFI Discover, to create opportunities for non-traditional CPD for STEM teachers (e.g. museums, zoos, science galleries).



Theme 3: The introduction of new teaching and learning modalities that would enhance STEM education in our schools and for which there is a strong evidence base.

The following actions are designed to enhance student engagement and participation in STEM, both within and outside of formal school settings.

Consider how the following actions could support the introduction of new teaching and learning modalities to enhance STEM education in our schools:

1. Develop a means of recognising participation in informal (extra-curricular) STEM events and activities (e.g. Science Fairs, BTYSTE, SciFest, CoderDojo, Intel MiniScientist) into the STEM curriculum and assessment at Primary and Post-primary levels, e.g. in an e-portfolio of achievement. Such digital archives of learning and personal development need to become part of the assessment for learning. The model used for the Science Foundation Ireland Discover Primary Science and Maths programme at primary school could be explored.
2. Promote real engagement with fundamental science concepts and principles through application to real-life situations and practical work.
3. Foster evidence-based STEM education research in Ireland in order to support the introduction of new modalities in STEM teaching, learning and assessment.

Theme 4: The use of technology to enhance STEM learning

The following actions are designed to embed digital technologies within STEM so that teachers and learners can utilise modern technologies to support their learning.

Consider how the following actions could support the use of technology to enhance STEM learning:

1. Support the introduction of digital technology to facilitate international collaboration in STEM subjects between schools, and between schools and research facilities (e.g. remote telescopes, remote laboratories).
2. Exploit digital technology in promoting and facilitating new engagements between schools and enterprises, e.g. the use of online mentors to assist schools/learners with their STEM activities; using digital technology to bring real science and engineering into the classroom; new forms of CPD to educate teachers in computer science.

Theme 5: The promotion of STEM careers and the identification of methods to enhance the engagement of students in STEM subjects

The following actions are designed to promote STEM in general and to entice more students, particularly females, into STEM courses and careers now and into the future.

Consider how the following actions could support the promotion of STEM:

1. The promotion of STEM is deemed to be extremely important, please consider the following actions and how they might raise awareness of STEM among all in society, particularly students and their families?
 - i) Ambitious targets and a sustained, multi-faceted action plan for addressing the gender imbalance in specific STEM disciplines should be established and implemented as a matter of urgency.
 - ii) Identify and promote the range and diversity of career opportunities available to STEM graduates as early as possible in primary and post-primary schools.
 - iii) STEM disciplines should be promoted as being crucial to personal development and citizenship in the 21st century.



2. STEM curriculum and assessment should be linked to wider ethical, legal, and societal issues, such as STEM's role in addressing global challenges (food, water, and energy security; biodiversity loss; etc.).
3. Engineering and technology should be integrated into the structure of science education at all levels, according the core ideas of engineering design and technology with the same status as core ideas in the other major science disciplines.
4. Promote and facilitate the 'adoption' of a school, or a cluster of schools, by a local STEM industry/enterprise.

Theme 6: Conclusions and general recommendations proposed in the STEM Report

The following overarching actions are aimed at ensuring Ireland has a high-quality graduate output aligned with national economic needs now and into the future.

1. Establish the STEM 2020 Partnership - a fixed-duration, public-private (enterprise-exchequer) partnership to create a fund to support a prioritised set of agreed, specific initiatives consistent with the recommendations of this report. This would entail pooling of resources from enterprise partners, philanthropy and crowdsourcing with resource-matching by the exchequer (DES, DJEI, SFI) over a five-year period. A fund of €8M per annum for five years, equally subscribed from public and private interests, is envisaged.
2. Establish STEM education research as a national research priority with sustained funding through SFI.
3. Create an annual 'Excellence in STEM Teaching' award scheme to recognise those teachers who are pioneering innovations in STEM education and who are outstanding educators.
4. The STEM Policy Statement should go beyond Science, Technology, Engineering and Mathematics to take account of the role of the Arts. Thus, the acronym STE(A)M should be considered, where A represents the Arts and Design (including design thinking).

The Consultation Process

The Consultation Process will gather the observations of stakeholders, in relation to the above actions, by posing the following questions:

- Are the actions clearly articulated and if not, how they might be further enhanced?
- Are the actions achievable and who needs to be involved in order to achieve success?
- What might success look like in relation to the above actions and are there any good examples or models that can inform their implementation?
- Are there any other actions that should be captured in the STEM Policy Statement?

The DES will engage in both face-to-face and online consultation around these actions. We will meet with a sample of parents and students at post-primary and primary to discuss the actions under Themes 3, 4, 5 and 6 while consultation with other stakeholders will focus on all 6 themes. In addition, the DES has developed an online survey to gather the views of the wider public in relation to these proposed actions.

Stakeholders are invited to provide feedback via an online survey at:

www.surveymonkey.com/r/STEMPolicy2017



APPENDIX 2: STEM Education Stakeholder Consultation

The Gresham Hotel, O'Connell Street, Dublin
 Tuesday 13th June 2017
 10.30 - 14.30

Time	Activity
10:30	Registration <ul style="list-style-type: none"> Participants sit in groups of 8-10 Mix of participants at each table
10:45	Welcome and introduction <ul style="list-style-type: none"> Background – STEM Education Report Development of STEM Policy Statement What we want to achieve Consultation Format
11:00	Theme 1: Preparation of Teachers for STEM education in Ireland <ul style="list-style-type: none"> Short presentation <ul style="list-style-type: none"> Actions outlined in STEM Review Report Points coming up from consultation Group work - consider the following: <ol style="list-style-type: none"> What are the implementation priorities required for these actions? Is there anything missing? Who needs to be involved? Are you aware of any examples where this or similar actions have worked well? Groups report back
11:30	Theme 2: Supporting STEM Teachers within the system
11:55	Themes 3 & 4: The introduction of new teaching and learning modalities that would enhance STEM education in our schools and for which there is a strong evidence base
12:20	Theme 5: The promotion of STEM careers and the identification of methods to enhance the engagement of students in STEM subjects
12:50	LUNCH
13:20	Theme 6: Conclusions and general recommendations
13:45	General report back on main points raised
14:00	Open discussion and reaction to main points
14:20	Closing Remarks <ul style="list-style-type: none"> Exit Cards