Exploring Coding – a CPD initiative to support the introduction of the junior cycle short course in Coding

Interim Report - September 2016

A collaborative CPD initiative with
Lero – the Irish Software Research Centre and Intel Ireland

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Introduction

The *Framework for Junior Cycle* (2015) outlines the key educational changes that the Department of Education and Skills (DES) is putting in place for young people in the first three years of their post-primary education, and represents one of the most significant educational reforms in Ireland since the foundation of the state. The framework incorporates a shared understanding of how teaching, learning and assessment practices should evolve to support the delivery of a quality, inclusive and relevant education that will meet the needs of all junior cycle students, now and in the future.

Short courses are a new and optional curricular component within the *Framework for Junior Cycle*. Short courses allow a school the flexibility to broaden the range of learning experiences for students, meet student needs, address their interests, and encompass areas of learning not covered by the combination of curricular subjects available in the school. Short courses require 100 hours of student engagement and are assessed through Classroom-Based Assessments, and reported on to parents/guardians and students by the school.

In 2014, the National Council for Curriculum and Assessment (NCCA) developed nine short courses which schools may opt to include in their junior cycle programme. As part of this work, Lero – the Irish Software Research Centre, was commissioned to write a short course, which was entitled *Coding,* in the area of computer science. This represented the first time that computer science could formally appear on the Irish curriculum and also the first time that students could profile their achievement in this area of learning. The course specification was made available to schools in 2014 and revised further in 2016[1].

The Junior Cycle for Teachers (JCT) school support service was established in 2013 to assist schools in implementing their junior cycle programme through the provision of high quality continuing professional development (CPD) opportunities and relevant learning and teaching resources.

Lero is Ireland's national software research centre, headquartered at the University of Limerick and involving all seven Irish universities and Dundalk Institute of Technology. Lero was founded in 2005.

In late 2015, JCT, Lero and Intel Ireland established a collaborative CPD initiative entitled *Exploring Coding*, involving 22 post primary schools which will run from January 2016 – January 2017. The initiative was designed to:-

- examine the current provision and opportunities within schools for Information and Communications Technology (ICT)[2] - related curriculum components at Junior Cycle
- support and document the experiences of a small number of schools as they incorporate aspects of the short course in *Coding* within their junior cycle programme.
- explore further options to support schools and teachers in their implementation of the short course in *Coding*

Participating schools received a donation from Intel Ireland to support their work. This donation comprised of a set of electronic devices or development boards known as Galileo Gen 2[3], as well as a number of component kits.

As well as providing a brief background to the introduction of the short course, this interim report documents the initial findings of the initiative at its mid-way point and will outline: -

[1] http://www.curriculumonline.ie/Junior-cycle/Short-Courses/Coding

[2] There is sometimes confusion over the use and meaning of the terms computer science, information technology, digital literacy, etc. The definitions in Appendix 1 may assist in your understanding of the various terms throughout this report.

[3] http://www.intel.ie/content/www/ie/en/embedded/products/galileo/galileo-overview.html

- key observations from the 'expression of interest' process as to current practice in Irish schools in the area of computer science
- a description of initial CPD activities
- the progress within schools to date

Section 1 Background

The introduction of *Coding* as an option for students at Junior Cycle follows developments on the international stage recognising the importance of Computer Science as a discipline. This is echoed in the rationale in the short course specification:-

'Computer Science is present in every aspect of modern society... A fundamental understanding of how computer hardware and software operate and relate to everyday life is an increasingly important area of learning for students. Problem solving and computational thinking skills are developed… as students build and create software projects using their own ideas and imagination. The course looks to build on any coding skills that primary students might have experienced while offering insight into possible future studies in computer science and software engineering' (p.7)

Computer science education is being prioritised in many countries as the reality of opportunities in computer science related careers grows and is projected to continue growing for the next number of years. In England, a new computing curriculum was introduced in 2014 as an entirely new foundational school subject [1]. Computer science is now taught to every child at every level from primary onwards. In the USA, a group of 100 advisors within the computing community, several states and large schools districts, technology companies and other organisations have joined forces to develop conceptual guidelines for states and districts creating a K-12 pathway in computer science [2]. New Zealand [3], Germany [4], Israel [5] and many more countries have embraced computer science in their educational systems.

In the Irish context, the Higher Education Authority (2016)[4] examined progression rates across a range of fields of study in Irish higher education. In comparison to the national average for non-progression of 16% in 2012/13, non-progression within computer science was considerably higher at 25%. There are many reasons why this dropout is high. They include misunderstandings about the nature of the subject, difficulty in differentiating between computer science, digital literacy and information technology as well as public perceptions reflecting stereotypes about people who engage in computer science.

The introduction of a short course in *Coding* at junior cycle will seek to address the above issues by:-

- Informing students about the nature of the area of learning
- Equipping students with computational thinking skills and problem solving skills
- Enabling them to make informed choices about choosing further studies or a career in computer science

[4] Higher Education Authority (2016), A study of progression in Irish higher education 2012/13 to 2013/14, p.23. Accessed at http://www.hea.ie/sites/default/files/hea-progression-irish-higher-education_final.pdf

Section 2 Observations from the 'expression of interest' process

In late 2015, a letter and brochure were circulated to schools inviting them to express their interest in becoming involved in the *Exploring Coding* initiative. This call received an unprecedented level of interest from across the country and 19 schools were selected from the 128 schools that expressed interest. A further three schools were added to the project in May 2016. A list of participating schools is included in Appendix 2.

Schools were identified for participation using the following criteria:-

- Schools that engaged with the short course in *Coding* via NCCA consultation meetings and/or Network Schools.
- Schools that engaged in previous Lero initiatives
- Schools that possess existing practice and/or teacher expertise and/or currently provide curricular time at junior cycle in the learning area of computer science.

It is also noteworthy that due to the industrial relations dispute at the time, only schools from within the Education and Training Boards (ETB) sector were identified for participation.

The expression of interest process provided an overview of the practice in Irish schools with regard to computer science. Of particular interest are:-

1. Profile of nominated teachers
2. Existing practice with regard to computer science/coding
3. The schools' rationale for the development of this area of learning at junior cycle

Profile of nominated teachers

As part of the expression of interest process, school were asked to nominate two teachers who would lead learning in *Coding* as part of the initiative. The following graphs examine this data in relation to teacher gender as well as teacher subject expertise.

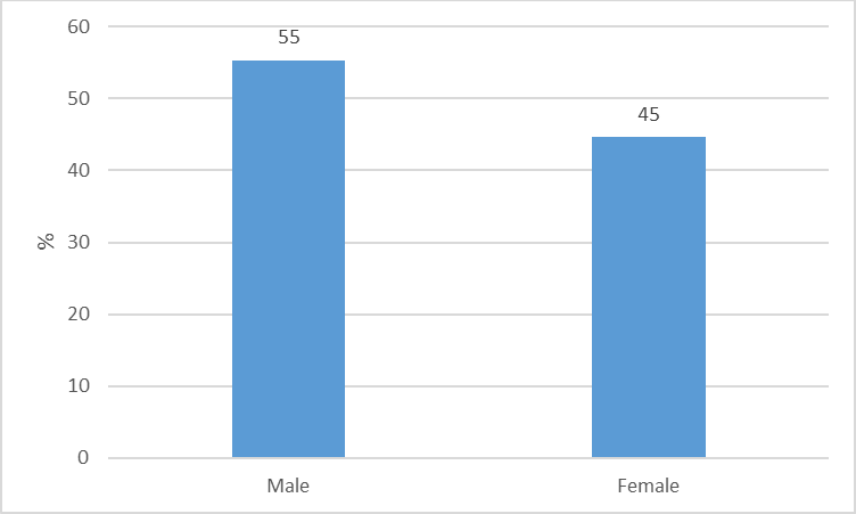


Fig. 1: Gender (%) of nominated teachers (n=244)

Of the teachers nominated 55% were male and 45% were female. From the 22 schools selected for the initiative, the gender breakdown is 63% male and 37% female (n=43)

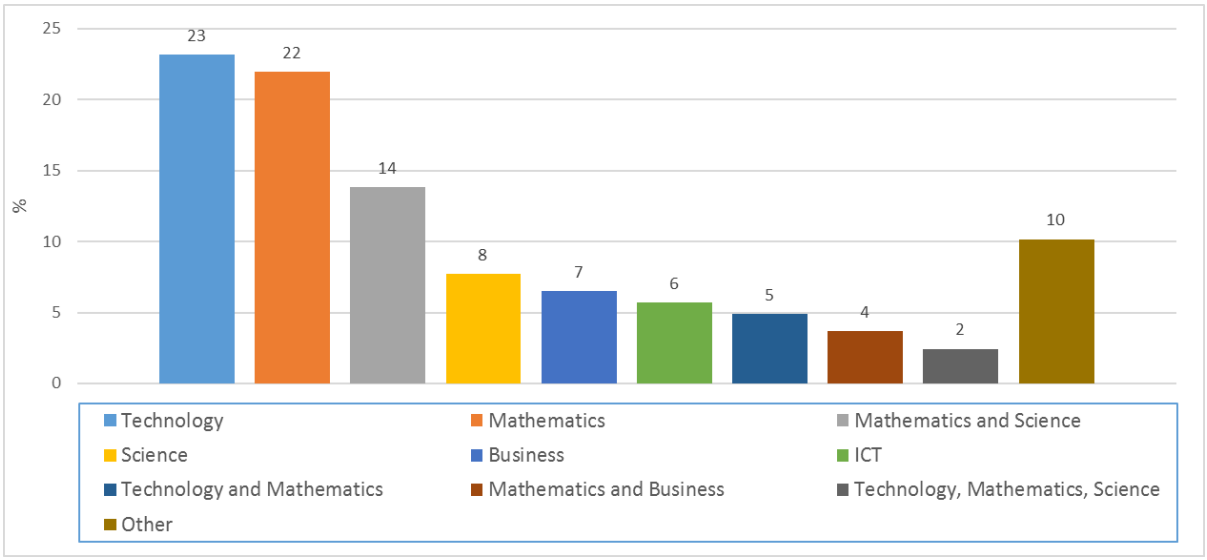


Fig. 2: Teacher expertise (%) of nominated teachers (n=246)

Of the teachers nominated, the subject expertise lay predominantly in the areas of technology (23%) and mathematics (22%), as well as science and business to a lesser extent. Only 10% of teachers nominated had teaching expertise outside of these four subject areas. From the 22 schools selected for the initiative, the breakdown is extremely similar with only 7% of participating teachers with teaching expertise outside of the four areas above (n=43). Please note that in the above graph, the figure for teachers of ICT reflects those reported to teach ICT only, and that teachers across all of the other categories may have taught ICT also.

The expertise in the area of computer science varied, but in the sample of the 22 participating schools, many teachers had undertaken courses and seminars delivered by various providers (e.g. Lero, the Irish Computer Society, the Professional Development Service for Teachers - PDST, Computers in Education Society of Ireland – CESI, British Educational Training and Technology Show - BETT).

Three of the participating schools had participated in the Postgraduate Certificate in 21st Century Teaching and Learning, *Bridge 21 Programme* from Trinity College, Dublin which allowed teachers gain experience in various online platforms, electronic devices and programming languages.

At the higher end of expertise, a small number of teachers had qualifications to BSc, Graduate Diploma or MSc. Level in Computer Science, while a number had worked in the IT industry before entering teaching.

<u>Existing practice with regard to computer science/coding</u>

Many schools have existing practice in the area of ICT at junior cycle level, but it was clear that this differed greatly from school to school with regard to:-

- the title of the area of learning,
- the type of general practice in ICT, and specific practice in computer science,
- the time provision for ICT.

The **title of the area** of learning included ICT, Computers, Computer Science, Coding and Programming. Modules were mentioned such as Programming and Web design, which indicated a wide spectrum of practice from school to school. A small number of schools mentioned lunchtime and/or afterschool Coding clubs or links with local community based clubs or *Coderdojos*.

The **type of practice** reported in the 'expression of interest' process varied significantly from school to school also. Many schools engaged in basic digital literacy skills such as file management, and the use of applications such as Microsoft Office (word-processing, spreadsheet management, email, etc.)

Some schools built their digital literacy skills around a centralised platform such as Google Apps for Education – GAFE, Schoology, Microsoft 365 for Education. These schools incorporated a high level of technology in their learning and teaching practice and sometimes incorporated certification opportunities, such as ECDL or Microsoft Office Specialist, into their practice

A small number of schools also engaged in other digital literacy skills such as animation.

It is important to note that the above types of learning which relate to digital literacy are not specified within the short course in *Coding*. So by taking a closer look at the computer science related practice within the sample of the 22 participating schools, the following examples were evident:-

- Use of block based introductory programming environments (Scratch, Blockly)
- Use of online platforms to support learning (Kahn Academy, Google CS First)
- Engaging in Code Competitions and Initiatives (Google Call to Code, Hour of Code, CanSat)
- Use of electronic devices (Raspberry Pi, Arduino)
- Basic engagement with programming languages (HTML/CSS, JavaScript, Python)
- App Development (MIT App Inventor)

Time provision differed greatly from school to school, and the following graphs explore the total time committed to ICT in a year-by-year analysis.

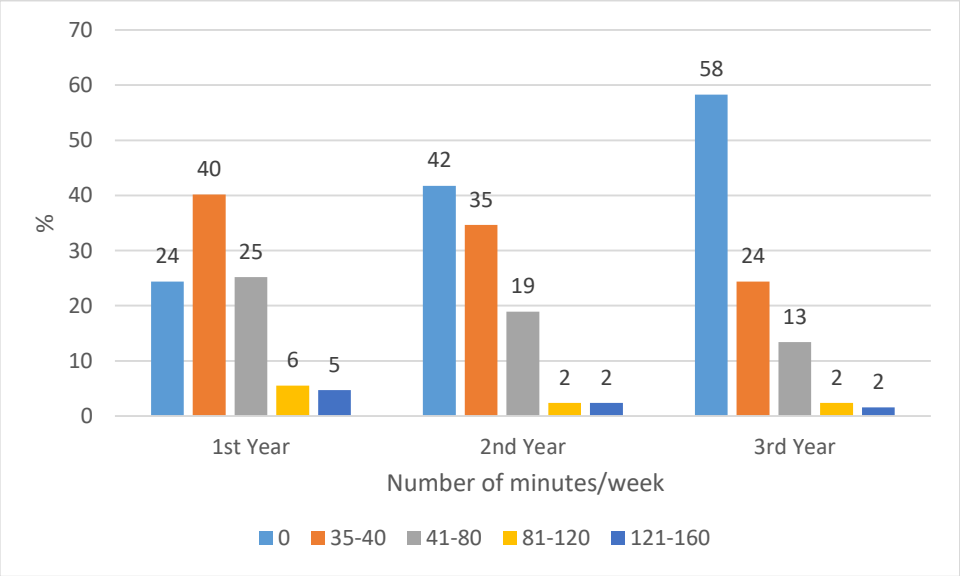
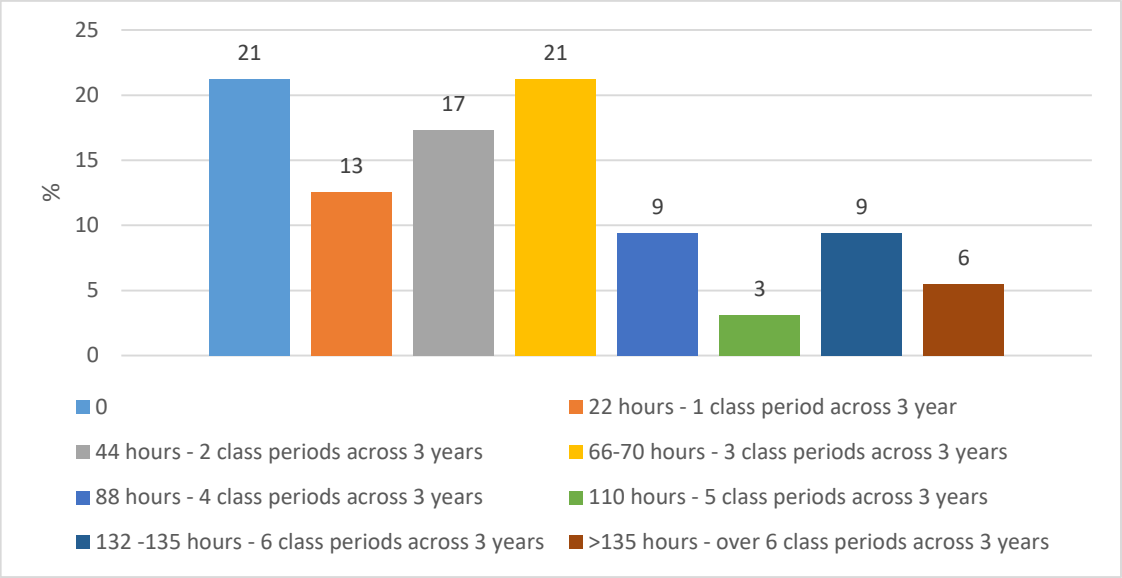


Fig. 3: Time allocated to ICT each year across Junior Cycle (n=127)

The above graph shows a huge variation in practice with regard to ICT. Firstly, close to one quarter (24%) of schools who expressed an interest in partaking in this initiative did not have curricular time allocation for ICT in first year, and the likelihood of this increased in subsequent years, with 42% not having time provision in second year, and 58% in third year.

Two fifth of schools (40%) reported having a single (35-40 minute) class period in first year, with this reducing to just under a quarter (24%) of schools in third year.

Also, a sizable cohort, 25%, offered up to two class periods (80 minutes) in first year, with this reducing to just 13% of schools in third year.



Time allocated to ICT across Junior Cycle (n=127)

The above graph reports the total time allocation across the three years and again shows a huge variation in practice. It is interesting to view this graph in the context that to offer a short course, an allocation of 100 hours of student engagement is required. It is interesting that over one quarter (27%) of schools commit four class periods or more as their total time allocation across the three years, which is the equivalent of 88 hours.

The variation across schools is emphasised further where, by comparison to the above, just over one fifth (21%) of schools who expressed an interest in participating in the initiative did not have time allocated to the area of learning in any of the three years.

<u>The schools' rationale for the development of this area of learning at Junior Cycle</u>

Within the sample of the 22 participating schools, there were a number of key reasons why the schools wished to include the short course in Coding in their students' junior cycle programme.

The schools wished to:-

- Provide opportunities for students to develop particular skills (computational thinking, logical thinking, collaborative skills, numeracy skills, developing projects using hardware devices). A number of principals felt that engaging in these skills would enrich the learning environment, improve student engagement and motivation, and lead to better student outcomes and better informed choices regarding future study.
- build on the student interest in computer science which was evident in existing practice (coding club, transition year) or within the learning taking place in local primary schools.
- allow students experience what a career in programming and computer science will involve and help them make informed decision if applying for further studies in the area of learning.

- promote the school as a centre of excellence in their local area with regard to ICT. Many schools had existing links with third level institutes and local industries. A small number of schools wished to be at the 'cutting edge' in developing practice around this short course. In addition, a number of schools felt that the introduction of the short course would allow the school to develop and formalise the practice within their school.
- Engage with a community of other schools to share best practice in the area. Many teachers expressed an interest in developing their own skills in the area.

Section 3 Description of Initial CPD Activities

The 22 schools that were selected to participate in the Exploring Coding Pilot were offered the following CPD supports as they trialled aspects of the *Coding* short course within their school.

CPD Event 1 – Regional Twilight Meeting (January 2016)

The initial session provided information about the initiative, and the short course within the Framework for Junior Cycle, a description of careers and opportunities in computer science. A school case study was presented and schools were also invited to share details of the practice within their own school.

CPD Event 2 – Full Day Workshop (January 2016 – Lero)

During this national event which was hosted by Lero in the University of Limerick, teachers explored the short course specification, followed by a number of hands-on workshops in computer science and computational thinking. The tools and technologies included were:-

1. Kahn Academy[5]
2. CS Unplugged[6]
3. Teaching London Computing[7]

CPD Event 3 – Full Day Workshop (February 2016 – Intel)

At this national event, which was hosted by Intel Ireland in Leixlip, teachers received a workshop on the Intel Galileo Gen 2 board. Software drivers and the Arduino API were installed during the workshop and participants engaged with a set of materials to familiarise them with the hardware.

It is interesting to note that the above event in Intel received a huge level of positive media attention, both locally and nationally. Many schools were subsequently contacted by local newspapers and radio, and reported that it helped raise awareness of the initiative within their school and wider community.

Following the above events, teachers were asked to select and trial aspects of the short course. This involved planning a unit of work and documenting their progress over a number of weeks.

[5] https://www.khanacademy.org/
[6] http://csunplugged.org/
[7] https://teachinglondoncomputing.org/

Section 4 Progress within schools to date

Schools and teachers were aware that reporting on their progress was an important aspect of this initiative, and all agreed to do so. As well as email and phone communications, a visit to each school was undertaken in April 2016. This allowed teachers to report on what aspects of the short course they had undertaken and reflect, with their school management, on their successes and challenges. It also allowed the schools to receive context-specific support after three months experience with the initiative.

Listed below are various aspects explored during the school visits:-

- Aspects of the short course which were initially undertaken
- Successes at a school level
- Challenges at a school level
- Successes at a classroom level
- Challenges at a classroom level
- The use of electronic devices to support student learning

Aspects of the short course which were initially undertaken

Fifteen schools provided details of the learning outcomes explored and computational thinking concepts that were covered during the initial part of the initiative (Feb-April 2016). Schools also detailed the resources that they employed in teaching these areas.

As expected, the majority of schools commenced with learning outcomes from Strand 1 - *Computer science introduction*, which explored computational concepts such as Algorithmic Thinking and Evaluation, (74%) and Decomposition and Abstraction to a lesser extent (50%). Some schools designed units of work which included learning outcomes from Strand 2 - *Let's get connected*, which predominantly entailed concepts Algorithmic Thinking and Abstraction.

Only a small number of schools explored learning outcomes from Strand 3 - *Coding at the next level.*

Successes at a school level

Many schools felt that engaging with the short course was meeting the needs of their students for a number of reasons:-

- Students were entering school with some experience and lots of interest in this area of learning, and the short course offered increased choice and flexibility for their students
- Many past pupils from the school are now working in the technology area or related areas, and incorporating Coding within the junior cycle programme will help support others to do so.
- Engaging in the short course will allow students enter transition year and progress to senior cycle and beyond with a valuable skillset in technology and an enhanced ability to think logically as they approach projects in the future.

Leadership were happy to support staff in 'pushing their passion' for this valuable area of learning.

Schools also felt that including coding at junior cycle level was a reflection of their progressive ethos and their eagerness to excel in this innovative area. Some principals were happy that their particular school was being acknowledged for their work in promoting computer science, for continuing the work in place in local primary schools, and their strong links with local industries and third level institutions within their community.

Challenges at a school level

The allocation of 100 hours to include the short course of Coding on the school's Junior Cycle programme was identified as a challenge. Amongst the reasons mentioned were:-

- Tradition – From Section 2, we can see that time allocation for ICT classes varied from school to school. To include a new area of learning such as Coding, each school needed to reconsider the traditional allocation of time to various junior cycle subject areas. In some cases, incorporating a time allocation of 100 hours to support the short course in Coding was difficult. Some schools identified that the lack of a specific pathway to certification (e.g. senior cycle computer science) also compounded their potential to allocate additional time required at junior cycle.
- Planning the digital pathway – Finding the balance between learning in the area of Coding as well as the need to include other digital media skills such as file management skills, and skills with various applications and programmes to support learning across other subjects proved a challenging task.

An interesting consideration which schools were making was whether Coding was for *all* students or *some* students. In terms of timetabling, an important decision is whether Coding should be offered to all students as part of their core junior cycle experience, or should it be offered as an optional choice or, indeed, a compromise model between both options.

Successes at a classroom level

Teachers identified the wide range of resources to support learning as key to their successes in the classroom.

- Ease of block based programming for introductory lessons (Scratch, Blockly)
- Online Platforms (Kahn Academy, Google CS First)
- Hands-on logical thinking puzzles and activities (CS Unplugged)

A number of teachers commented on how the use of differentiated tasks allowed for the needs of all students to be met in the classroom.

Student motivation to engage in learning of this type which incorporates the use of devices and the use of digital skills, as well as engagement in group work, was reported to be very high.

Challenges at a classroom level

In order to establish coding as an established part of the curriculum the vast cohort of participating teachers identified the need for further training, support and resources to support learning and teaching, particularly in the area of pedagogical approaches (project-based learning, games based learning, inquiry based learning, etc.) and assessment of student work. Some teachers requested further upskilling in the use of electronic devices, such as the Intel Galileo board, to support student learning.

Although some of the participating teachers possessed qualifications in computer science, support for the development of further expertise in schools was called for, in the form of undergraduate or postgraduate programmes. A small number of teachers felt it important to explore, with the Teaching Council, the status with regard to teacher registration in the area of Coding/Computer Science.

The use of electronic devices to support student learning

A small number of schools had utilised the Galileo Gen 2 boards in the initial stages of the project. The majority of schools had decided to concentrate initially on an introduction to computer science, and perhaps utilise the development boards at a later stage to support student learning.

Many teachers felt that they needed more support and training to gain experience and confidence in working with this technology before utilising it in the classroom setting.

Of the few schools that did use the boards to date, the response was very positive in that:-

- The hardware boards allowed students to observe physical and practical uses of code away from the computer screen.
- Some students had a particular interest in and aptitude for working with hardware. Teachers facilitated this by allowing students to work independently or in small groups with the development boards.
- There is a very practical application within junior cycle technology as students can integrate the technology within junior certificate projects.
- In some schools, there is existing practice in hardware programming from engagement in competitions such as Young Scientist, SciFest and CanSat

A number of schools have utilised the Galileo boards outside of the junior cycle setting. Two schools reported using the board with transition year modules and identified their potential use to support learning within senior cycle engineering.

One school have very successfully shared the resources with a local Coderdojo to support students in the extra-curricular opportunity.

Section 5 Conclusion

At the midway point in this initiative, and considering the work to date, it is critical to acknowledge the efforts of the teachers and principals within the participating schools. Developing practice and leading learning in an innovative and new area of learning like *Coding* is a challenging task. The openness of teachers to contribute to the research element of the project to inform the pathway for future schools is hugely appreciated.

In the coming months, the participating schools may engage in the following CPD opportunities:-

- CPD Event 4 2-Day CPD Event (Oct 2016)
- CPD Event 5 1-Day CPD Event (Jan 2017)
- Online Sharing of Practice Webinars (Sept 2016 – Jan 2017)

At the conclusion of the project, a final report will be delivered.

A significant interest amongst schools was identified via the expression of interest process (128 schools) and future CPD activities have the potential to be shaped on the findings of this initial initiative.

References

[1] Society, T.R. Shut down or restart? 2012; Available from: https://royalsociety.org/~/media/education/computing-in-schools/2012-01-12-computing-in-schools.pdf.

[2] A Framework for K-12 Computer Science Education. 2016 [cited 2016; Available from: https://k12cs.org/.

[3] Bell, T., P. Andreae, and L. Lambert, Computer Science in New Zealand high schools, in *Proceedings of the Twelfth Australasian Conference on Computing Education - Volume 103*. 2010, Australian Computer Society, Inc.: Brisbane, Australia. p. 15-22.

[4] Hubwieser, P., Computer Science Education in Secondary Schools -- The Introduction of a New Compulsory Subject. Trans. Comput. Educ., 2012. **12**(4): p. 1-41.

[5] Gal-Ezer, J., et al., A high school program in computer science. Computer, 1995. **28**(10): p. 73-80.

Appendix 1

There is sometimes confusion over the use and meaning of the terms computer science, information technology, digital literacy, etc.

The definitions below from the Royal Society (2012) may assist you in your understanding of the various terms throughout the report:-

> Digital literacy (DL): should be understood to mean the basic skill or ability to use a computer confidently, safely and effectively, including: the ability to use office software such as word processors, email and presentation software, the ability to create and edit images, audio and video, and the ability to use a web browser and internet search engines. These are the skills that teachers of other subjects at secondary school should be able to assume that their pupils have, as an analogue of being able to read and write.
>
> Information Technology (IT): should be understood to mean the assembly, deployment, and configuration of digital systems to meet user needs for particular purposes.
>
> Computer Science (CS): should be interpreted as referring to the scientific discipline of Computer Science, covering principles such as algorithms, data structures, programming, systems architecture, design, problem solving etc.

The Royal Society (2012) *Shut down or restart? The way forward for computing in UK schools*. Available from: https://royalsociety.org/~/media/education/computing-in-schools/2012-01-12-computing-in-schools.pdf.

Appendix 2

The list of participating schools in the 'Exploring Coding' initiative are:

Abbey Vocational School, Donegal Town, Co. Donegal*
Adamstown Community College, Co Dublin
Ard Scoil Chiarain Naofa, Clara, Co. Offaly
Ballinamore Community School, Co. Leitrim*
Castleknock Community College, Dublin 15
Castletroy College, Co Limerick
Celbridge Community School, Co. Kildare
Coláiste an Chraoibhin, Fermoy, Co Cork
Coláiste Bhaile Chláir, Claregalway, Co. Galway
Colaiste Chiarain, Croom, Co. Limerick
Coláiste Mhuire Co-Ed, Thurles, Co. Tipperary
Comeragh College, Carrick-On-Suir, Co. Tipperary
Confey Community College, Leixlip, Co Kildare
Crana College, Buncrana, Co. Donegal*
Glenart College, Arklow, Co Wicklow
Killorglin Community College, Co Kerry
Kishoge Community College, Lucan, Co. Dublin
Nenagh Vocational School, Co Tipperary
St Brigids Vocational School, Loughrea, Co Galway
St Colman's Community College, Midleton, Co Cork
St Nessan's Community College, Limerick
St Oliver Post Primary, Oldcastle, Co. Meath
***These three schools joined the project in May 2016**