



Northern Ireland  
Assembly

# Research and Information Service Briefing Paper

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## Coding in schools

### Summary

Coding is the process of developing sets of instructions (computer programmes) that enable computers to carry out tasks. In recent years there has been criticism of the emphasis on teaching ICT, which relates to *using* software, in schools. It has been suggested that the focus should instead be on computer science, which relates to the more technical aspects of computing, such as *designing* software.

### Coding in schools in Northern Ireland

Coding is not directly referenced in the Revised Curriculum. However, ICT is included as a cross-curricular skill and there is some flexibility for schools to teach coding if they wish. There is little evidence on the extent to which this happens in practice, however it has been suggested that coding is rarely taught in primary schools or pre-GCSE.

With regard to informal teaching, there are a number of coding clubs and societies that operate at lunchtimes, after school and during the holidays, including 27 Code Clubs where pupils undertake projects to create video games or websites.

### Qualifications

The research suggests that the current range of ICT and computing qualifications available to students is too diverse and confusing. Employers have also questioned the usefulness of some such qualifications.

CCEA does not offer a GCSE in computing, although it plans to develop one for September 2017. At A Level the number of students taking ICT has increased by almost a third over the past seven years to 1487 entries. However, the same period saw a decline of 63% in the number of entries for Computer Studies (from 182 to 68).

### **Teacher training and teachers with a subject specialism in computing**

There is considerable variation in the extent to which coding is included in initial teacher education (ITE) and continuing professional development (CPD) courses across the training providers and CPD courses have been taken by a very small proportion of teachers. Momentum has suggested that there are “serious issues” in regard to training teachers so that they feel confident to teach coding.

The data suggest that 231 teachers registered with the General Teaching Council for Northern Ireland studied computing or computer science as the main subject specialism of their teaching qualification, representing 0.9% of registered teachers.<sup>1</sup>

### **Practice in other jurisdictions**

Internationally there is some variation in the practice of ICT and computing. In line with Northern Ireland, ICT tends to be offered as a cross-curricular skill, while computer science is more frequently included in specific courses at more senior levels. However, there is a trend towards the inclusion of coding within education, for example:

- England recently replaced ICT with computer science on the curriculum. Children as young as five will learn to create and debug simple programmes;
- Estonia is placing great emphasis on coding in schools in response to facing a shortage of computer programmers for its technology industry;
- In the Republic of Ireland coding was recently introduced as an optional short course for the revised Junior Certificate.

### **Conclusion**

This paper highlights a number of areas that could be given consideration, including:

- The emphasis on ICT rather than computing in the Revised Curriculum;
- The increasing number of A Level students taking ICT while the number sitting Computer Studies has decreased by 63% in seven years;
- The variation in the inclusion of coding in ITE and CPD across the training providers, the extent to which adequate training in coding is available and the capacity of teachers to teach coding;
- The proportion of teachers with a subject specialism in computing;
- The international trend towards teaching coding in schools at a younger age.

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<sup>1</sup> Not all teaching qualifications provide details of a subject specialism

## 1 Introduction

Coding, or computer programming, is the process of developing sets of instructions allowing computers to carry out specific tasks. These sets of instructions are considered computer programmes.<sup>2</sup>

In recent years many people, including the chairman of Google, Eric Schmidt, have criticised the emphasis on teaching ICT rather than computer science in schools.<sup>3</sup> ICT in the curriculum focuses on skills for *using* software, while Computer Science has been described as a 'rigorous academic discipline' incorporating coding.<sup>4</sup>

This briefing paper provides an overview of the formal and informal teaching of coding in schools in Northern Ireland, and considers qualifications and teacher training in this regard. It also explores practice in other jurisdictions.

## 2 Coding in schools in Northern Ireland

### Formal teaching

The Revised Curriculum includes ICT as a cross-curricular skill and teachers should provide pupils with opportunities to develop and apply ICT concepts. However, there are no direct references within the curriculum to computing concepts such as programming.<sup>5</sup>

While coding is not included in the curriculum, there is flexibility for schools to choose to teach it. The Department advises that at key stages 2 and 3 coding may be taught within Using ICT.<sup>6</sup> However, Momentum suggests that at primary and pre-GCSE, teaching of coding rarely happens in practice, pointing to issues around a lack of knowledge among teachers and reduced demand at these levels.<sup>7</sup>

The Department does not collect data on the number of schools teaching computer programming and C2k does not collect data on the usage of individual programmes or tools. CCEA has noted "limited" examples of the use of programming tools in post-primary pupil work submitted for moderation.<sup>8</sup>

It has been suggested that Northern Ireland should ensure that the computing curriculum incorporates a balance of computer science, digital literacy and information technology.<sup>9</sup> The Minister for Education, John O'Dowd MLA, has stated that while he

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<sup>2</sup> European Schoolnet (2014) *Computing our future: Computer programming and coding* Belgium: European Commission

<sup>3</sup> The Economist (2014) *A is for algorithm* [online] Available at: <http://www.economist.com/news/international/21601250-global-push-more-computer-science-classrooms-starting-bear-fruit>

<sup>4</sup> The Royal Society (2012) *Shut down or restart? The way forward for computing in UK schools* London: The Royal Society

<sup>5</sup> As above

<sup>6</sup> Information provided by the Department of Education, February 2015

<sup>7</sup> Turley, B, McConnell, R., Noble, M. (2014) *Northern Ireland: A Global Leader of the Digital Economy A Strategic Action Plan* Momentum, Ulster Bank

<sup>8</sup> Information provided by the Department of Education, February 2015

<sup>9</sup> UK Digital Skills Taskforce (2014) *Digital Skills for Tomorrow's World*

does not plan to define coding within the curriculum, there could be scope for consideration of its inclusion when the curriculum is next subject to review.<sup>10</sup>

### Tools for teaching

The online programming tool Scratch is available in all schools; this allows pupils to create and share interactive stories, games, and art.<sup>11</sup> A 2013/14 survey of primary teachers attending CCEA ICT workshops suggested that around 55% of teacher respondents have and use Scratch. The Department reports that where programming is taught at post-primary, the programming language Logo is still being used.<sup>12</sup>

At post-primary the tools Game Maker and Mediator are available, as well as a Computer Programming Environment (CPE) which is designed to support GCSE and A Level. At the time of writing 73 schools had been granted access to the CPE.<sup>13</sup>

### Informal teaching of coding

The Department states that many schools run Scratch clubs and some have introduced the programming language Python. These activities are mainly offered as an extra-curricular activity, and therefore may only be attended by a small proportion of pupils.<sup>14</sup>

**Table 1: Examples of informal coding clubs in Northern Ireland<sup>15</sup>**

Initiative	Age range	Format	Overview
<b>Code Club</b>	9-11	After school clubs or held in other venues such as libraries	Volunteers teach projects such as the creation of video games or websites. There are 27 Code Clubs in NI
<b>CoderDojo</b>	7-17	Often take place on Saturdays	Community-based Dojos (clubs) vary in their activities but all show young people how to code and develop software. There are around 13 Dojos in NI
<b>Miniversity</b>	4-12	After school and holiday clubs	Miniversity's lesson plans cover a range of areas of ICT, including coding. There are 18 after school clubs in NI
<b>TechFuture Girls</b>	10-14	After school or lunchtime clubs	Teaches computing skills including coding, "themed around girls' interests"

<sup>10</sup> NI Assembly Official Report (2015) *Official Report: Monday 09 February 2015* [online] Available at: <http://aims.niassembly.gov.uk/officialreport/report.aspx?&eveDate=2015/02/09&docID=222649>

<sup>11</sup> Scratch [online] Available at: <http://scratch.mit.edu/>

<sup>12</sup> Information provided by the Department of Education, February 2015

<sup>13</sup> As above

<sup>14</sup> As above

<sup>15</sup> Code Club [online] Available at: <https://www.codeclub.org.uk/> ; CoderDojo [online] Available at: <https://coderdojo.com/about/> ; Information provided by CoderDojo, February 2015; Miniversity [online] Available at: <http://www.thecomputerclub.co.uk/> ; TechFuture Girls [online] Available at: <https://www.techfuturegirls.com/about-cc4g/>

## Initiatives

In 2014/15 the Department is supporting two programmes that incorporate computer programming. These target a small proportion of pupils (the total school population at primary and post-primary in 2013/14 was 315,521 pupils). A number of other initiatives have been offered in recent years, although the Department was not involved in them.<sup>16</sup>

**Table 2: Examples of coding initiatives<sup>17</sup>**

Coding initiative	Initiative	Reach	Overview
<b>Departmental initiatives</b>	IT's Your Choice	12,910 pupils* from KS2-post-16	Sentinus will deliver coding activities, including roadshows, robotics programming, a bursary scheme and a careers day
	SMART Technology programme	3,000 KS2 pupils*	The Department funds this Sentinus programme which includes a strand introducing pupils to coding - PICAXE programming software is used to control microbots
<b>Other initiatives</b>	Year of Code (2014)	UK-wide	This independent campaign aimed to promote coding by highlighting events and sourcing funding for educational organisations. However, it was criticised for a perceived lack of technical expertise
	Hour of Code	60m students globally	This initiative aimed to encourage individuals to spend an hour learning to code. There were 25 Hour of Code events in Northern Ireland in 2014

## Qualifications

The Council for the Curriculum Examinations and Assessment (CCEA) has not yet developed a GCSE incorporating the more technical aspects of computer science, although students may take a GCSE in Computing by another exam board.<sup>18</sup> CCEA plans to develop a GCSE in Computer Science for first teaching from September 2017 (subject to Business Case Approval).<sup>19</sup>

<sup>16</sup> Department of Education *Northern Ireland summary data* [online] Available at: [http://www.deni.gov.uk/index/facts-and-figures-new/education-statistics/32\\_statistics\\_and\\_research-numbersofschoolsandpupils\\_pg/32\\_statistics\\_and\\_research-northernirelandsummarydata\\_pg.htm](http://www.deni.gov.uk/index/facts-and-figures-new/education-statistics/32_statistics_and_research-numbersofschoolsandpupils_pg/32_statistics_and_research-northernirelandsummarydata_pg.htm)

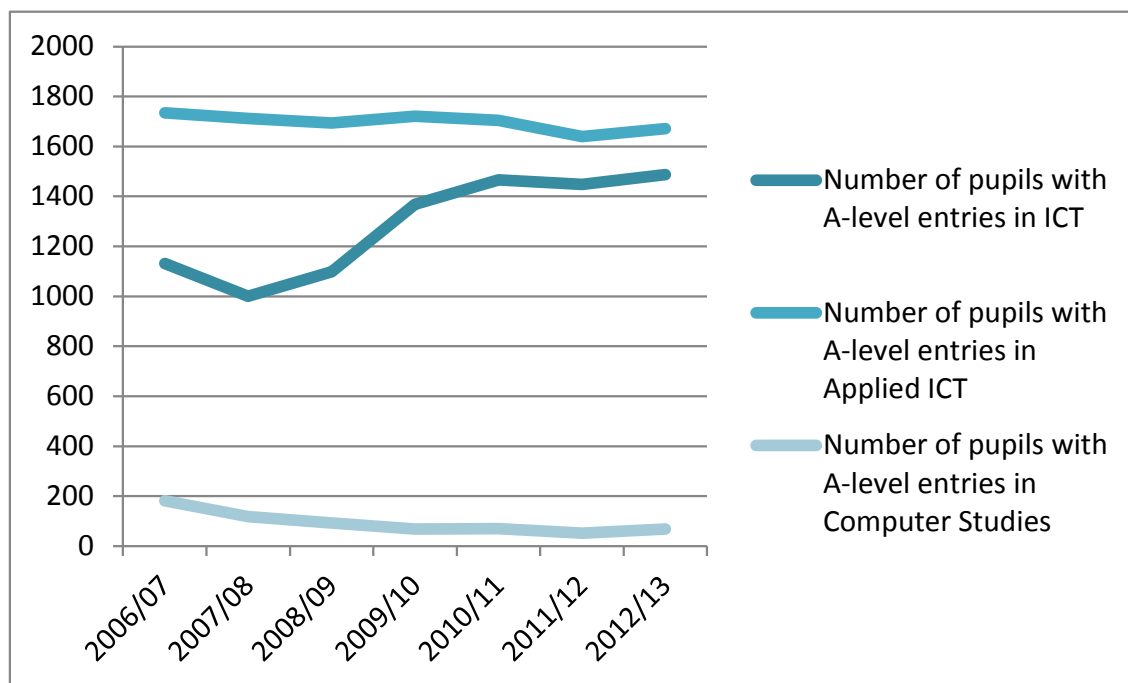
<sup>17</sup> Information provided by the Department of Education, February 2015; *Year of Code* [online] Available at: <http://yearofcode.org/>; Naughton, J. (2014) "Why Year of Code already needs a reboot" *The Guardian* [online] Available at: <http://www.theguardian.com/technology/2014/feb/15/year-of-code-needs-reboot-teachers>; Hour of Code [online] Available at: <http://hourofcode.com/us>

<sup>18</sup> E-skills UK (2014) *The women in IT Scorecard* London: BCS

<sup>19</sup> Information provided by the Department of Education, February 2015

Figure 1 shows that over the past seven years there has been a 31% increase in the number of students taking A Level ICT, while at the same time there has been a 63% decrease in the number taking Computer Studies.

**Figure 1: Students with A Level examination entries in ICT and Computer Studies 2006/07 – 2012/13**



In September 2013 CCEA introduced a Software Systems Development qualification. The first cohort comprised 37 candidates from five schools, while 173 candidates from 13 schools took part in the second cohort.<sup>20</sup>

It has been suggested that the range of ICT and Computer Science qualifications in Northern Ireland (as well as England and Wales) is too diverse and confusing. Many of the qualifications are perceived to be of limited value to employers.<sup>21</sup>

**Teacher training**

There is considerable variation in the inclusion of coding in both initial teacher education (ITE) and continuing professional development (CPD) courses across the different providers of teacher training, as outlined in the Table 3. The table also shows that CPD courses in recent years have been attended by a very small proportion of teachers.

<sup>20</sup> Information provided by the Department of Education, February 2015

<sup>21</sup> The Royal Society (2012) *Shut down or restart? The way forward for computing in UK schools* London: The Royal Society

**Table 3: Inclusion of coding in teacher training<sup>22</sup>**

Institution	Initial teacher education	Continuing professional development
<b>Queen's University Belfast</b>	<ul style="list-style-type: none"> <li>Capacity for more than 12 students annually on the PGCE for ICT/ Computing (including programming)</li> <li>Emphasis is on GCSE and A Level</li> </ul>	<ul style="list-style-type: none"> <li>Received DE and InvestNI funding to upskill teachers for the new A level in Software Systems Development - 20 teachers currently attending</li> <li>AllState provided a one week intensive course for A Level teachers in June 2013 and 2014</li> </ul>
<b>St Mary's University College</b>	<ul style="list-style-type: none"> <li>Post-primary students may take Computing and ICT as a subsidiary subject</li> <li>Some other students incorporate coding, e.g. BEd Maths students undertake a project using Scratch</li> </ul>	<ul style="list-style-type: none"> <li>None at present</li> </ul>
<b>Stranmillis University College</b>	<ul style="list-style-type: none"> <li>All primary and post-primary BEd students study coding</li> <li>Computer science is offered at BEd post-primary as a subsidiary subject</li> </ul>	<ul style="list-style-type: none"> <li>Has offered a range of CPD courses in programming from 2013/14</li> <li>41 teachers have undertaken the courses to date</li> </ul>
<b>University of Ulster</b>	<ul style="list-style-type: none"> <li>Not currently included</li> <li>Development of a coding module to be considered next year</li> </ul>	<ul style="list-style-type: none"> <li>Offering a module in Software Systems Development in 2014/15</li> <li>16 computer science teachers from ten post-primaries are taking the module</li> </ul>

In addition to the teacher training institutions outlined in Table 3, CPD for teachers in coding has been provided by organisations including the Curriculum Advisory and Support Service (CASS) and CCEA.<sup>23</sup>

- On behalf of the five ELBs, SELB provided a computer science and programming CPD programme lasting five days for 65 post-primary teachers over the past two academic years. This was supported through STEM funding provided to the ELBs by the Department;
- CCEA held 19 half-day workshops in 2014/15 for 309 primary teachers exploring samples of pupils' work in coding (using Logo and Scratch), and held Standard Setting events for post-primary teachers on samples of work in Using ICT, including coding through Game Maker;
- The Armagh Multi-Media Arts Centre has provided limited opportunities for teachers and pupils to take part in coding courses and activities (funded by DCAL).

<sup>22</sup> Information provided by the Department of Education, February 2015

<sup>23</sup> As above

Momentum suggests that there are “serious issues’ in Northern Ireland in terms of training teachers so that they are confident in teaching coding to students. It notes that a number of companies (such as Allstate, Kainos and Tascomi) work closely with local schools to support this.<sup>24</sup>

### **Proportion of teachers with a subject specialism in computing**

The General Teaching Council for Northern Ireland (GTCNI) is not required by law to register the subject specialisms of qualified teachers. However, where possible, GTCNI records a specialism subject for each individual’s teacher training and the main subject of their degree, if known.<sup>25</sup>

It is important to note that not all teaching qualifications provide details of a subject specialism, and that there may be teachers with a subject specialism that have not been brought to the attention of the GTCNI. However, the following figures give an indication of the number of teachers whose main subject was computing or computer science.

Computing or computing science is noted as the ‘main subject’ specialism of the teaching qualification of 231 registered teachers – representing 0.9% of registered teachers. A further 196 (or 0.7%) have noted ICT as their main subject.<sup>26</sup>

## **3 Overview of other jurisdictions**

There is wide variability in the practice of ICT and computing internationally. In general, ICT tends to be available to most students, while fewer countries include the more technical aspects of Computing, including coding.<sup>27</sup> However, there is a growing trend towards including programming within education, whether on a compulsory or optional basis.<sup>28</sup>

In line with Northern Ireland, most countries include ICT as a cross-curricular skill, often only offering it as a discrete subject at the later stages of schooling. For example, younger pupils tend to use computers for purposes such as producing text or writing reports, making presentations and carrying out internet searches. Specific computing courses at more senior levels of school tend to include programming.<sup>29</sup>

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<sup>24</sup> Turley, B, McConnell, R., Noble, M. (2014) *Northern Ireland: A Global Leader of the Digital Economy A Strategic Action Plan* Momentum, Ulster Bank

<sup>25</sup> Information provided by the Department of Education, February 2015

<sup>26</sup> From data provided by the Department of Education – correct at 5<sup>th</sup> February 2015

<sup>27</sup> Sturman, L., Sizmur, J. (2011) *International Comparison of Computing in Schools* Slough: NFER

<sup>28</sup> European Schoolnet (2014) *Computing our future: Computer programming and coding* Belgium: European Commission

<sup>29</sup> Sturman, L., Sizmur, J. (2011) *International Comparison of Computing in Schools* Slough: NFER



**Figure 2: Inclusion of coding at primary/ post-primary across European countries<sup>30</sup>**

	Belgium (Flanders)*	Denmark	England	Estonia	Finland*	The Netherlands*	Republic of Ireland
Primary							
Post-primary							

Offered
  Compulsory

\* Planned inclusion

With regard to teacher training, the literature suggests that there tends to be a delay between changes being introduced in the curriculum and the preparation of teachers to deliver them.<sup>31</sup>

## 4 England

In September 2014 England implemented a new curriculum at both primary and post-primary replacing ICT with the essentially new subject of computer science.<sup>32</sup> This will make England the only country in the world that requires for every child to study computer science from primary school onwards (although academies do not have to follow the curriculum).<sup>33</sup>

Beginning at key stage 1 (around age five), pupils will be taught to create and debug simple programs, while at key stage 3 they will be taught to use two or more programming languages. At key stage 4 study aims to cover computer science at sufficient depth to allow students to progress to higher levels of study or pursue a related career.<sup>34</sup>

### Qualifications

In 2010 a new GCSE in Computing was developed by the awarding body OCR; this was the first GCSE to have this focus and it incorporates theory, programming and

<sup>30</sup> Adapted from European Schoolnet (2014) *Computing our future: Computer programming and coding* Belgium: European Commission

<sup>31</sup> European Schoolnet (2014) *Computing our future: Computer programming and coding* Belgium: European Commission

<sup>32</sup> UK Digital Skills Taskforce (2014) *Digital Skills for Tomorrow's World*

<sup>33</sup> Peyton Jones, S. (2015) "Code to Joy" *Times Educational Supplement* 16<sup>th</sup> January 2015, pp.26-30

<sup>34</sup> Gov.uk (2013) *National curriculum in England: computing programmes of study* [online] Available at: <https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study/national-curriculum-in-england-computing-programmes-of-study>

practical investigation<sup>35</sup> (AQA has since developed a computing GCSE). In 2013 the then Education Secretary Michael Gove announced that computer science will be included in the EBacc as a science option,<sup>36</sup> giving it academic status.

The awarding bodies have revised existing A Levels in computer science for first teaching from September 2015. OCR states that its new A Level will build on the new GCSE in computing, focus on programming and computational thinking and include an expanded maths focus.<sup>37</sup>

### Teacher training

The vast majority of primary school teachers in England do not have a computing background<sup>38</sup> and a recent survey has found that 60% of teachers do not feel confident about delivering the new curriculum.<sup>39</sup>

The Coalition Government has provided £3.5m to up skill teachers in the new computing curriculum. This has mainly been used to support a network of 400 'master teachers' who will pass on their skills and knowledge; and to support the Barefoot Computing programme for primary teachers (including 800 workshops run by volunteer experts). Stakeholders such as Computing at School, Microsoft and Google, have supported this teacher training.<sup>40</sup>

A free CPD pack aiming to help teachers plan, teach and assess the new computing curriculum has been developed by BCS, the Chartered Institute for IT in England, and funded by the Department for Education.<sup>41</sup>

However, this approach to up skilling teachers for the new curriculum has been criticised and described as 'skimping'.<sup>42</sup> It has been suggested that an additional £20m will be required by 2020 to support the implementation of the new curriculum, as well as providing dedicated time for CPD.<sup>43</sup>

## 5 Estonia

In response to a shortage of computer programmers for its expanding technology industry, Estonia is placing great emphasis on programming. Local schools can decide

<sup>35</sup> Sturman, L., Sizmur, J. (2011) *International Comparison of Computing in Schools* Slough: NFER

<sup>36</sup> Gov.uk (2013) *Computer Science to be included in the EBacc* [online] Available at: <https://www.gov.uk/government/news/computer-science-to-be-included-in-the-ebacc>

<sup>37</sup> OCR (2015) *AS and A Level Computer Science* Cambridge: OCR

<sup>38</sup> UK Digital Skills Taskforce (2014) *Digital Skills for Tomorrow's World*

<sup>39</sup> As above

<sup>40</sup> As above

<sup>41</sup> Peyton Jones, S. (2015) "Code to Joy" *Times Educational Supplement* 16<sup>th</sup> January 2015, pp.26-30

<sup>42</sup> The Economist (2014) *A is for algorithm* [online] Available at: <http://www.economist.com/news/international/21601250-global-push-more-computer-science-classrooms-starting-bear-fruit>

<sup>43</sup> UK Digital Skills Taskforce (2014) *Digital Skills for Tomorrow's World*

whether to include coding on a compulsory basis,<sup>44</sup> and some schools teach coding to pupils aged from six years.<sup>45</sup>

Teachers are required to integrate the cross-curricular theme of ‘technology’ across a range of areas, for example, using computer programming tools in maths lessons. Schools can choose from a range of optional subjects to include within technology, including programming and computer science.<sup>46</sup>

### **Teacher training**

The ProgeTiger programme provides training and resources for teachers on coding, including seminars and conferences.<sup>47</sup>

### **Qualifications**

The ‘Certification of secondary school students in ICT’ allows for the certification of students’ ICT skills, including coding, acquired by the completion of compulsory education.<sup>48</sup>

## **6 Finland**

Currently, ICT and Computing are not mandatory and they are taught discretely, rather than on a cross-curricular basis. In Finland the national curriculum allows each municipality and school to design individual programmes for ICT studies.<sup>49</sup>

However, a new curriculum is being prepared for implementation from August 2016, and is expected to include coding on a cross-curricular basis.<sup>50</sup>

### **Teacher training**

The evidence suggests that student teachers in Finland do not sufficiently develop educational computer skills during their training. It also indicates that serving teachers require training in this area.<sup>51</sup>

### **Qualifications**

At the end of upper secondary education students in Finland take the matriculation exam, in which students select four or more tests from a range including language, mathematics, sciences and humanities. Preparations are being made for ICT to be

<sup>44</sup> European Schoolnet (2014) *Computing our future: Computer programming and coding* Belgium: European Commission

<sup>45</sup> The Economist (2014) *A is for algorithm* [online] Available at: <http://www.economist.com/news/international/21601250-global-push-more-computer-science-classrooms-starting-bear-fruit>

<sup>46</sup> European Schoolnet (2014) *Computing our future: Computer programming and coding* Belgium: European Commission

<sup>47</sup> As above

<sup>48</sup> As above

<sup>49</sup> Sturman, L., Sizmur, J. (2011) *International Comparison of Computing in Schools* Slough: NFER

<sup>50</sup> European Schoolnet (2014) *Computing our future: Computer programming and coding* Belgium: European Commission

<sup>51</sup> Valtonen, T., Mäkitalo-Siegl, K., Kontkanen, S., Pöntinen, S., Vartiainen, H. (2012) ‘Facing Challenges with New Teachers’ Use of ICT in Teaching and Learning” *Bulletin of the IEEE Technical Committee on Learning Technology* Vol. 14, No 4, October 2012 pp. 46-49

included within the matriculation exam,<sup>52</sup> but it is not yet clear whether coding will be included.<sup>53</sup>

## 7 Republic of Ireland: inclusion in the revised Junior Certificate

Programming is not compulsory at primary, although schools can choose to offer it as an elective subject. At lower secondary level, coding is now offered as a distinct course and students build and create software projects.<sup>54</sup>

An Irish language version of the programming tool Scratch has been made available by the Professional Development Service for Teachers, allowing students in Irish-medium schools to code in Irish.<sup>55</sup>

### Teacher training

Initial teacher education includes compulsory ICT training and many providers offer optional or compulsory modules on coding. Continuing professional development courses in programming have also been designed in conjunction with the Irish Software Engineering Research Centre, and digital content is available through the Scoilnet website.<sup>56</sup>

### Qualifications

At post-primary coding was introduced as an optional short course as part of the revised Junior Certificate in September 2014. All the key skills within the Framework highlight the use of digital technology and students will complete a project in computer science.<sup>57</sup>

Officials have stated that computer science is a 'major priority' for the Government, and that it could be included in the Leaving Certificate in the future.<sup>58</sup>

## 8 Israel

Israel has the highest density of technology start-ups in the world, helped in part by its computer science programme in post-primary schools which is considered to be the best internationally. It was introduced in post-primary schools as a subject (on an

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<sup>52</sup> Eurypedia (2015) *Finland: Assessment in General Upper Secondary Education* [online] Available at:

[https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Finland:Assessment\\_in\\_General\\_Upper\\_Secondary\\_Education](https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Finland:Assessment_in_General_Upper_Secondary_Education)

<sup>53</sup> European Schoolnet (2014) *Computing our future: Computer programming and coding* Belgium: European Commission

<sup>54</sup> As above

<sup>55</sup> As above

<sup>56</sup> As above

<sup>57</sup> As above

<sup>58</sup> Fegan, J. (2014) *Junior Cert students will study coding* Irish Independent [online] Available at: <http://www.independent.ie/irish-news/education/junior-cert-students-will-study-coding-30383449.html>

optional basis) in 1995, representing a step-change away from a sole focus on ICT. The principles of the curriculum include:<sup>59</sup>

- Computer science should be taught on a par with other scientific subjects;
- Two different programmes are required; one for students with a general interest in computer science and one for those with a more specialist interest;
- Teachers certified to teach computer science must have adequate formal education in the subject.

The success of the system is linked in part to these principles, in particular the combination of the curriculum and requirements for teacher education, together with research conducted in computer science education.<sup>60</sup>

Research indicates that the difference between the proportion of male and female students who take computer science in high school is relatively small. In addition, students who took the computer science matriculation exam were more likely to study computing in higher education.<sup>61</sup>

### Teacher training

To teach computer science at post-primary teachers must have at least a bachelor's degree in computer science and a formal certificate in teaching computer science education. A national Computer Science Teacher Centre supports the continuing professional development of computer science teachers.<sup>62</sup> Israel has over 1,000 teachers trained in computer science.<sup>63</sup>

## 9 United States

In the US practice varies across states and jurisdictions. However, research suggests that computer science has been 'marginalised' within education and is not treated as a core subject.<sup>64</sup> The evidence indicates that school standards place too much emphasis

<sup>59</sup> Hazzan, O., Gal-Ezer, J., Blum, L. (2008) "A model for high school computer science education: The four key elements that make it!" *Technical Symposium on Computer Science Education - SIGCSE* pp. 281-285 and Wagstaff, K. (2012) *Can We Fix Computer Science Education in America?* Time [online] Available at: <http://techland.time.com/2012/07/16/can-we-fix-computer-science-education-in-america/>

<sup>60</sup> Hazzan, O., Gal-Ezer, J., Blum, L. (2008) "A model for high school computer science education: The four key elements that make it!" *Technical Symposium on Computer Science Education - SIGCSE* pp. 281-285

<sup>61</sup> Armoni, M., Gal-Ezer, J. (2014) "High school computer science education paves the way for higher education: the Israeli case" *Computer Science Education* Vol. 24, pp. 101-122

<sup>62</sup> Hazzan, O., Gal-Ezer, J., Blum, L. (2008) "A model for high school computer science education: The four key elements that make it!" *Technical Symposium on Computer Science Education - SIGCSE* pp. 281-285

<sup>63</sup> The Economist (2014) *A is for algorithm* [online] Available at: <http://www.economist.com/news/international/21601250-global-push-more-computer-science-classrooms-starting-bear-fruit>

<sup>64</sup> Lang, K., Galanos, R., Goode, J., Seehorn, D., Trees, F. (2013) *Bugs in the System: Computer Science Teacher Certification in the US* New York: Association for Computing Machinery

on the skills-based aspects of computing, with little focus on conceptual aspects of computer science.<sup>65</sup>

### Teacher training

Research indicates that training for computer science requires improvement and that funding for the professional development of computer science teachers is “insufficient.”<sup>66</sup> For example, each state has its own process for training, its own definition of computer science and varying practices in terms of implementation. A recent report recommended that teacher training programmes include programmes on computer science.<sup>67</sup>

### Qualifications

Advanced Placement exams are administered by the College Board, a national organisation. Students can sit a Computer Science exam mainly focused on Java programming (offered in just 10% of schools),<sup>68</sup> and a Computer Science Principles course including programming and emphasising computational thinking is due to be added in 2016.<sup>69</sup>

## 10 Conclusion

This paper has explored a growing trend internationally toward the inclusion of coding or computer programming in school education. It has highlighted a number of areas that could be given further consideration, including:

- The emphasis on ICT rather than computing in the Revised Curriculum;
- The increasing number of A Level students taking ICT while the number sitting Computer Studies has decreased by 63% in seven years;
- The variation in the inclusion of coding in ITE and CPD across the training providers, the extent to which adequate training in coding is available and the capacity of teachers to teach coding;
- The small proportion of teachers with a subject specialism in computing;
- The international trend towards teaching coding in schools at a younger age.

<sup>65</sup> Wilson, C., Sudol, L.A., Stephenson, C., Stehlik, M. (2010) *Running on empty: The failure to teach K-12 Computer Science in the Digital Age* New York: Association for Computing Machinery

<sup>66</sup> Hazzan, O., Gal-Ezer, J., Blum, L. (2008) “A model for high school computer science education: The four key elements that make it!” *Technical Symposium on Computer Science Education - SIGCSE* pp. 281-285

<sup>67</sup> Lang, K., Galanos, R., Goode, J., Seehorn, D., Trees, F. (2013) *Bugs in the System: Computer Science Teacher Certification in the US* New York: Association for Computing Machinery

<sup>68</sup> Wagstaff, K. (2012) *Can We Fix Computer Science Education in America?* Time [online] Available at: <http://techland.time.com/2012/07/16/can-we-fix-computer-science-education-in-america/>

<sup>69</sup> AP *AP Computer Science Principles* [online] Available at: <https://advancesinap.collegeboard.org/stem/computer-science-principles>