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Re-Engineering the ICT Profession: A Global Call for Collective Action

UNTIL RECENTLY, Korea and Israel were the only places where computer science in the strictest sense was taught in primary and secondary schools. But now, the United Kingdom coalition government is in a rush to introduce more coding because Eric Schmidt of Google criticized the information technology and communications curriculum, observing:

> *The country that invented the computer is throwing away your great computer heritage by failing to teach programming in schools. I was flabbergasted to learn that today computer science isn't even taught as standard in UK schools…Your IT curriculum focuses on teaching how to use software, but gives no insight into how it's made [28].*

Although Google has been accused of not paying enough taxes in the United Kingdom, David Cameron, the UK prime minster, has taken Schmidt's advice on this point. As a result, the Department for Education (DfE) has been tasked with introducing the teaching of programming under the banner of computer science almost to the exclusion of digital literacy and information technology (ICT) - an approach that is causing significant dissent amongst ICT educators. To an ICT professional in New Zealand, Noeline Wright, it seems that ICT has become 'a political football' in the UK [34].

ICT Professional Development

A key issue in introducing more computer science has always been the lack of adequately trained teachers. One approach that cuts down costs is to encourage teachers to join a community of practice [15,32,33]. I came to this conclusion when the 1980s computer networks were established in most UK schools and I became an IT adviser. But I quickly found that the one-day computing courses we offered at the Inner London Education Computing Centre (ILECC) were ineffective for many London teachers for three reasons: they had not studied computing in their first degree; they did not own their own computer; and, they were only offered one computing session a year. So in 1992 I founded one of the first free online communities of practice, the MirandaNet Fellowship (see Figure 1), where teachers, teacher educators, researchers, policy makers and developers can support each other in figuring out the best ways to use computers in schools to enhance learning [19].

MirandaNet now has over eight hundred members in eighty countries who share their professional experience and expertise in the search for what works in the classroom and what does not. They debate online in a professional knowledge creation event that we call a MirandaMod [19] as well as publish articles, papers, and case studies to inform educators globally (see Figure 2). This community approach to professional development for teachers has recently been endorsed by four New Zealand faculty of computer science [30] in reviewing how teachers in New Zealand might keep up with the move towards computing science in their new curriculum for schools - a curriculum and professional development program that has been widely praised [3].

The Professional Voice

MirandaNet has two main sister organizations in England who provide a professional voice in ICT: ITTE, the teacher educators in IT [13], and NAACE [20] for educators, technologists and policy makers. Since the 1990s these three professional organizations have worked closely on designing the various iterations of the national curriculum in ICT in co-operation with the Department of Education. In essence their wide approach for preparing pupils in primary and secondary schools is summed up by Zaki Abu Bakar [1] who

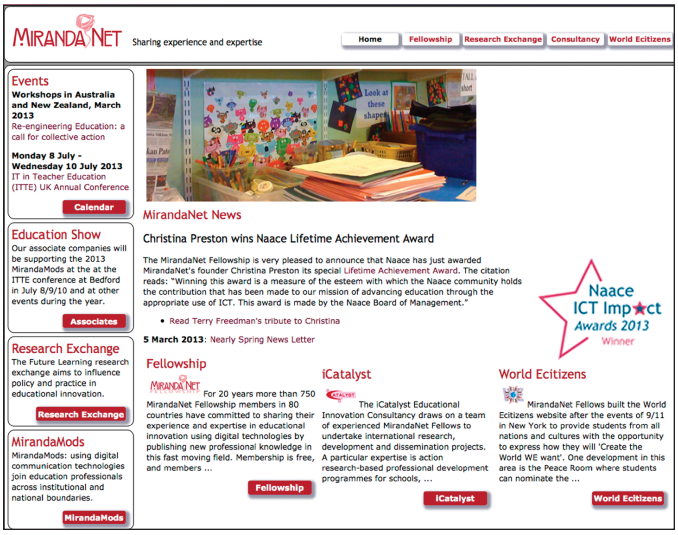

Figure 1. MirandaNet Fellowship front page.

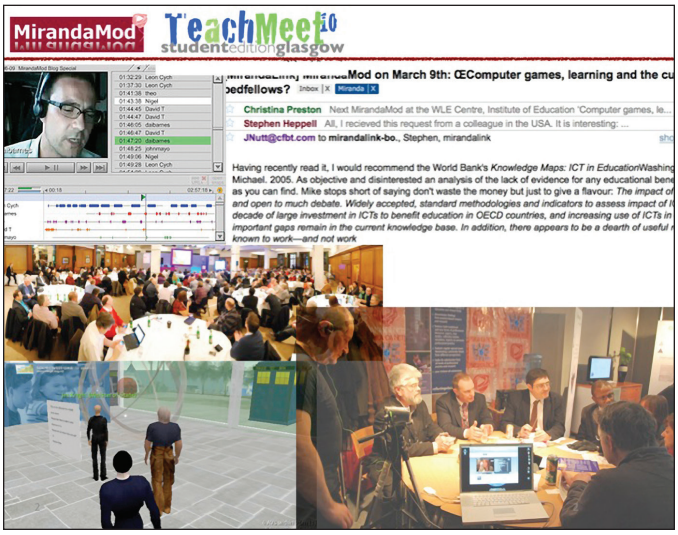

Figure 2. MirandaMods held in a variety of professional development contexts.

advised that after school, a balanced ICT curriculum should continue for specialist computer science students in further and higher education. These students should be "well rounded and well educated," following a wide curriculum rather than one that only produces industrial specialists in computing science – "we need those who understand computational thinking but also have skills in design, marketing and entrepreneurial skills."

An important contribution was made to the debate about the breadth of the curriculum by UNESCO as early as 1994, now updated in 2000 [31]. In this curriculum for schools report, the role of ICT in the student curriculum is seen in four distinct groups:

ICT literacy–focusing on curriculum developed from the European Computer Drivers Licence and "covers the use of ICT in daily life in a competent and intelligent way," such as applying ICT tools and applications to a range of personal tasks.

Application of ICT in Subject Areas–covering the application of specific ICT tools which "work within specific subject areas including languages, natural sciences, mathematics, social sciences and art." This approach includes generic tools and ICT skills addressed within the ICT literacy classification as well as "specific application software that can only be used in a specific subject area (for example mathematical software that only is of use within the area of mathematics)."

Integration of ICT across the curriculum–using a thematic, project based model, "examples of projects are described to demonstrate the use of ICT in a combination of subject areas where work is done on real-world projects and real problems are solved."

ICT Specialization–"designed for students who plan to go into professions that use ICT such as engineering, business and computer science or who plan to advance to higher education."

In England, however, the Royal Society (2012) definitions are better known [26]. The aim in this report is to advocate a more equal balance between information technology, digital literacy, and computer science. Agreement about what these terms mean, unfortunately, is under dispute. The Royal Society definition of information technology is not controversial: the use of computers, in industry, commerce, the arts and elsewhere, including aspects of IT systems architecture, human factors, project management and so on. However, the Royal Society definition of digital literacy seems limited as they only refer to "the general ability to use computers, a set of skills rather than a subject in its own right."

The main dissent, however, turns on how much computer science is possible or desirable in school, especially in the early years. The Royal Society defines computer science as a rigorous academic discipline, encompassing programming languages, data structures, algorithms, and so on. Until this Royal Society report, it was thought better in England to start these subjects in detail in higher and further education where teachers are more likely to be up to date.

Introducing Coding

New developments in teaching aids mean that teaching coding is now more viable for non-specialist teachers. Scratch, a visual approach to a programming, is used to create interactive stories, games, music and art and share them online. See Figure 3.

Furthermore, Raspberry Pi, (Figure 4), a credit-card sized computer that plugs into a TV and a keyboard, can be used for many of the things that a desktop PC offers, such as spread sheets, word-processing and games. Raspberry Pi also plays high-definition video. It is particularly valuable for promoting programming activity and computational thinking.

In another development, the Code Club [5], with Prince Andrew as a patron, has also emerged to train young volunteers to run after school coding clubs in order to supplement the efforts of ICT

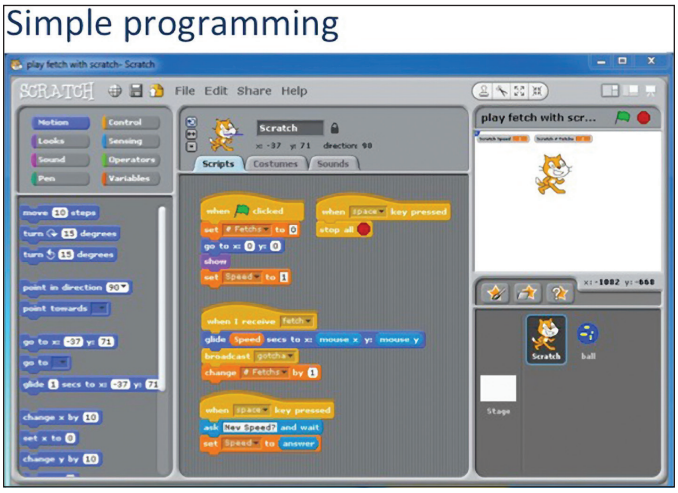

Figure 3. Scratch, a simple visual approach to coding.

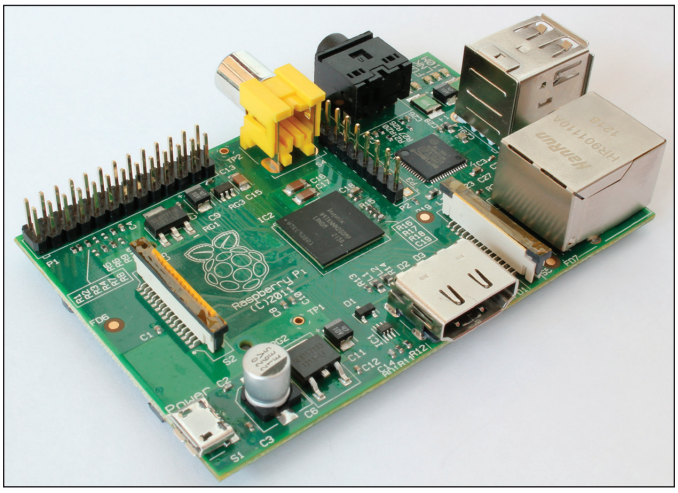

Figure 4. Raspberry Pi.

teachers who are not trained to teach coding. In terms of training in programming, teachers are also joining the community of practice 'Computing at School' (CAS) Working Group. CAS, a grass roots organization that aims to promote the teaching of computing at school, is in a collaborative partnership with the British Computing Society (BCS) through the BCS Academy of Computing, and has formal support from other industry partners. CAS is also in partnership with the Royal Academy of Engineers (RAEng) [25].

To the surprise of ITTE, NAACE, and MirandaNet, Michael Gove told an international audience of 25,000 at the BETT12 exhibition [10] that the current ICT curriculum in England was "boring." At a time when England needs to export, this comment seemed to be unwise: computers have been in English schools for thirty years with a worldwide reputation for excellence. It may be true that some teachers had interpreted the curriculum as a vehicle for teaching Microsoft Office since they had not had enough professional development to do more, but the curriculum itself was not "boring." In addition, if this new computing curriculum is introduced without a professional development program, the dangers of boring pupils are even greater.

Unfortunately, ICT teacher educators find it hard to take seriously the pronouncements of a Secretary of State for Education who said, "those academics who have helped run the university departments of education responsible for developing curricula and teacher training courses …are the enemies of promise."

> *You would expect such people to value learning, revere knowledge and dedicate themselves to fighting ignorance. Sadly, they seem more interested in valuing Marxism, revering jargon and fighting excellence [11].*

Writing this polemic in a right-wing tabloid newspaper, the Daily Mail, we can only assume that Gove is not seeking the academic vote. Michael Wilshaw, the chief inspector of OFSTED, shows a lack of understanding of teacher educators' partnerships with schools by calling on them to come out of their "ivory towers" [33]. This is a strange attack from an ex-head teacher who thought that the most important achievement of the school he ran in a disadvantaged London community was that a few pupils won places at Oxbridge. He believes all pupils should aspire to this level of academic excellence and yet castigates academics.

In contrast, the fact that 'academics' are out of political favor became obvious when the Department for Education asked the new group of teachers, Computing at School (CAS), the British Computing Society (BCS), and Royal Academy of Engineering (RAEng) to design the new primary ICT curriculum. The draft Programs of Study (PoS) were sent out for consultation and the amendments of ITTE, NAACE, and MirandaNet appeared to have been accepted. But, according to the RAEng website, in December 2012, after the agreed text had been submitted to DfE, the RAEng, CAS and BCS were again asked for their advice on how to amplify the computer science component of the draft PoS in order to emphasize that teaching computer science is of paramount importance. Behind closed doors, decisions have been taken to call the curriculum itself *Computing* not *Information and Communications Technology* and to expand the computer science element, specifically coding, to take up more than two thirds of the suggested PoS [25]. Consultation on this new document is requested in April of 2013 but the lack of democracy in the process so far has not endeared teachers to the initiative and has created unnecessary tensions.

Questions to Government

Along with ITTE and NAACE, the international MirandaNet Fellowship is putting to the Department for Education a series of questions that have been crowd sourced among the members on this Computing curriculum that is now out for consultation [8].

In the first place, the MirandaNet Fellowship observes that in this new consultation document, the introductory paragraphs read well as a broad curriculum is promoted. But this strategy is undermined by the details in the four key stages that reveal key omissions and a lack of understanding of progression.

However, MirandaNet Fellows have a series of questions that should be answered before the extreme changes suggested in the POS are made. The first two points are about democratic process and the appropriate involvement of all expert partners.

- Why did the political coalition depart from the democratic process at this consultation stage by placing the design of the ICT curriculum for schools entirely in the hands of organizations that have no experience in designing curricula for schools and excluding those that have? The insight of CAS, RAEng and BCS into computing issues is welcome but would not an exchange of views with experts in schools be more valuable in ensuring that pupil achievement is assured?
- A key reason for changing the ICT curriculum is to meet the needs of industry but the intense focus on 'computing' at a young age seems to contradict industry preferences summed up by MirandaNet Fellow, Rachel Jones, recently a MirandaNet industry associate and now the head of the Elliot Academies: *Thinking back to the NextGen report and the previous debates we have had about industry needs, particularly in terms of the games industry, developing collaborative problem solving approaches to technical and creative challenges is perhaps regarded as a 'soft skill', but it has high value in practice in the workplace. It is a rare individual that combines outstanding programming, narrative and graphical skills, but a collaborative development team that challenges itself to excel in melding these can achieve a great deal. Starting children off earlier in evaluating what works well across a range of devices, then encouraging them to create, test and redevelop digital products together, and to understand the value of feedback could generate a greater passion for the subject and harness individual creativity to build greater capacity [14].*

Other MirandaNet questions focus on the breadth of computing as a topic that teachers and children should be introduced to in secondary and primary schools:

- Have educators with experience in ICT or industrialists been consulted about the omission of 'creativity' 'criticality', 'design issues' and 'evaluation' from the latest draft of the computing curriculum? What are the research statistics on the numbers of students, especially girls, who the change to a two thirds coding content will disaffect? Is there any evidence that this approach will create a pool of programmers? Is it certain that it is only programmers who are required in the computer industry?
- Is there any research that shows that teaching algorithms to five year olds will improve their chances of being good programmers in adult life? How will these activities interface with learning to read and write?
- If e-safety is now omitted from the school curriculum, who will have the responsibility to help young people develop the social skills and discerning understanding about protecting themselves online?
- To what extent is the government sure that "Code Club" volunteers, encouraged by the government and industry sponsored, can compensate for the lack of professional development available to help existing ICT teachers to convert to computer science?
- What will be the rewards for teachers who undertake significant retraining in computational thinking in order to teach it effectively? Will sabbaticals be available?
- The draft computing curriculum PoS are so narrow in focus that schools that follow them will not pass the OFSTED inspections in their current form. Will the inspectorate be consulted on these new plans?

Rachel Jones, again, summed up MirandaNet members' concerns:

This primary curriculum as it now stands is utilitarian and lacks a development of creative application of information technology. It is focused largely on computational thinking and the development of straightforward computer science skills, both of which are perfectly useful, but overall the key stage content lacks breadth and progression. I would argue that the program is insufficient to develop the critical awareness, creativity and higher order thinking skills required in our workplace and indeed by individuals [14].

Seen as a model for the construction of knowledge, rhizomatic processes suggest the interconnectedness of ideas as well as boundless exploration across many fronts from different starting points. An educator reproduced this effect by creating a context within which the curriculum and knowledge are constructed by members of a learning community and which can be reshaped in a dynamic manner in response to environmental conditions.

Collaboration in Knowledge Creation and Dissemination

The MirandaNet Fellowship has a final question related to their practice and research over the years into the innovative

use of digital technologies in collaborative learning, knowledge creation and analysis of current professional knowledge. The question is:

> Now that the contribution of digital technologies to social and collaborative learning is omitted how will children and teachers in England know about the innovative ways in which computers facilitate transnational and remote collaboration in knowledge building?

We would like to see more attention in the curriculum given to this emerging area of importance that relates to games players engaging remotely in virtual worlds, remotely authored concept maps, social networking and micro-blogging. These democratic collaborative knowledge creation opportunities are causing ripples in social and cultural contexts although they not widely exploited for learning yet. Nevertheless MirandaNet, like many communities of practice, would find it difficult to operate without wikis, micro-blogging, social networking and videoconferencing tools. In addition, learning platforms and MOOCs seem to be transforming the ways in which learning is delivered, particularly informal and self-directed learning. See Figure 5. (One can also view this map at [19].) Greater understanding of these collaborative principles would also be valuable for teachers in schools even though assessment does not value them yet. Young people need guidance in using the power of these tools wisely.

As a long-standing community of practice, MirandaNet members first researched these online collaborative learning processes by observing how teachers share ideas on email - a process we called Braided Learning [22,23,24]. As technologies improve, more collaboration on new knowledge construction is possible as we demonstrate in our MirandaMods [19] using Web 2 combining video conferencing, micro-blogging, and remotely authored concept mapping to explore the value of communities of practice. The URL has been provided as well as an image of the map since already A4 paper reproduction of knowledge building is inadequate for this kind of collaborative work.

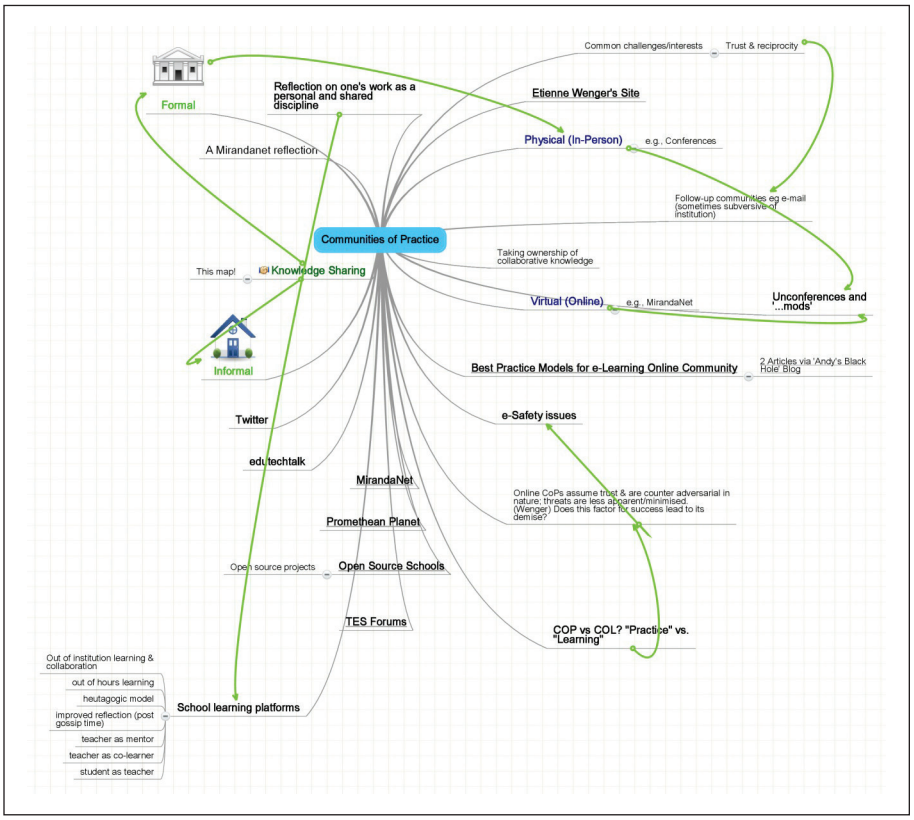

Figure 5. A remotely authored concept map on Mobile learning developed by MirandaNet members.

We have found that a MirandaMod creates a shared liminal space (see Figure 6) that is important to build on professional knowledge: inchoate and chaotic as learners' misconceptions, misunderstandings or simply lack of knowledge clash and co-mingle. 'Liminal space' is a term used generally to describe the dissolution of order in the individual brain during liminality that creates a fluid, malleable situation that enables new institutions, new customs and new expressions of commonality to become established.

MirandaNet Fellows Cuthell, Preston, Cych and Kuechel [6,7] argue that social liminal space can be conceptualized as anthropological and contains semiotic elements that can be visual as well as written. In the public sphere created at the interface of face-to-face and virtual communicative action, all learners, professional or otherwise, could act in the Brunerian sense [2] as scaffolds to support each other as they traverse liminal space together to reach shared and individual enlightenment and transformation.

Professor Mike Sharples, a MirandaNet Fellow, has also been working in the area of innovation in collaborative learning [29]. His Open University team offers two terms that help to describe the learning conditions demonstrated in a MirandaMod: seamless learning and rhizomatic learning. Seamless learning defines the experience of continuity of learning across a combination of locations, times, technologies or social settings. This can be seen as learning journeys that can be accessed on multiple devices, flow across boundaries between formal and informal settings, and continue over life transitions such as school to university and workplace.

Rhizomatic learning is derived from the metaphor of a plant stem that sends out roots and shoots that allow the plant to propagate itself through organic growth into the surrounding habitat. See Figure 7. Seen as a model for the construction of knowledge, rhizomatic processes suggest the interconnectedness of ideas as well as boundless exploration across many fronts from different starting points. An educa-

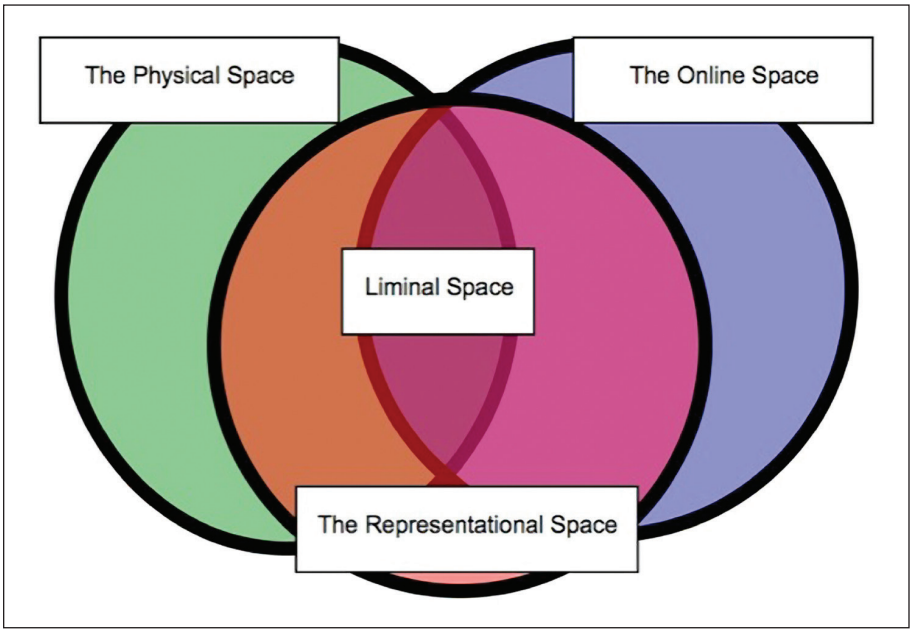

Figure 6. Liminal space theory adapted to include shared online spaces.

tor reproduced this effect by creating a context within which the curriculum and knowledge are constructed by members of a learning community and which can be reshaped in a dynamic manner in response to environmental conditions.

Figure 7. A rhizome providing a visual image for the way in which knowledge is constructed by self-aware expert communities adapting to environmental conditions.

These social, conversational processes, as well as personal knowledge creation, can be linked into unbounded personal learning networks that merge formal and informal media. Working with communities of teachers, Leask, Preston and Younie, all MirandaNet Fellows, have shown that teachers in communities can develop new theories and practice that are valuable for influencing policy at many levels [16,17].

There are many questions here about how educators and academics affect their own learning, the learning of students and the design of digital learning environments. Space needs to be made in the curriculum to ensure that important innovations in learning and democratic processes are acknowledged. Removing references to 'collaboration' in the draft ICT curriculum will not prepare pupils for further study or the world of work.

A Call for Collective Action

The way in which the new ICT curriculum has been designed in England is a cause for concern in the context of wider issues about the preservation of democracy processes and regard for professionalism. For example, government websites holding many years of resources and research developed by professionals have been closed down by the political coalition. For example, the British Educational Communications and Technology Agency (BECTA), the government agency for digital technologies in education, has funded a huge variety of publications developed by teachers and teacher educators. These publications can no longer be accessed as they could in 2010, since the Coalition has closed all the government websites including BECTA's research and professional development publications, the Teacher Training Agency ICT resource bank for teachers and Teachers' TV. A huge repository of resources, advice and evidence has been dismantled.

But developing collaborative strategies for building knowledge has also resulted in strategies for influencing government policy by strengthening professional judgment with 'crowd sourced' evidence. So far, teachers and academics have not been as good at publishing evidence in a single place as doctors have. The successful model used in the medical field, the Cochrane review [4], already adopts the notions of knowledge management to the managing and building of professional knowhow that can be scaled up by the submission of small studies that are analyzed with others to achieve a wider consensus on what works and what does not work. The expectation is that learner attainment will be raised by professionalizing teaching.

Independent global ownership by universities of the platform means that the teaching profession and the associated academics do not have to trust the continued funding of government websites when the political regimes change drastically. In 2012, in a later speech, Google's Schmidt, suggested that governments pose the greatest threat to the internet. From London's Science Museum, he warned about the rise of censorship and government cybercrime [27]. Hopefully, David Cameron was also taking note this time.

However, with this Schmidt announcement in mind, an international community of communities has been established, the Education Futures Collaboration, based at the University of Bedfordshire. The OECD [21, p.3] is also warning that *"in many countries, education is still far from being a knowledge industry in the sense that its own practices are not yet being transformed by knowledge about the efficacy of those practices."*

This independent organization is for educators, academics and companies who

wish to work collaboratively to improve the quality of education and make sure that knowledge is disseminated. The ideas, values and work strands underpinning the Education Futures Collaboration have been evolving for many years through the professional interests and work of a number of founding members. The Royal Academy of Engineers, the British Computer Society, and CAS will also attend to add pathways from their research and knowledge about computing science.

At the center of this development is data collection and publication by collaborative concept maps that can be authored remotely. Mapping Education Specialist knowHow (MESH) is a 'map of education' that provides access to subject and concept specific research-based knowledge about barriers to students' learning, including interventions most likely to remove barriers [19]. The MESH approach as shown in Figure 8 uses online graphical flowcharts or pathways to form maps, as a way of presenting complex knowledge, each node in the pathway providing a link to the display of more in-depth knowledge. The resources presented in these online pathways can be accessed in any web-based format such as text, audio or video and are underpinned with rigorous high quality research evidence of a professional knowledge base for the field of education.

The international universities that now fund the Education Futures Collaboration (EFC) offer a joined-up approach to any educators in digital technologies who want support for their research and evidence informed practice, managed and developed by education experts, independent of any government, and policy of the day [9]. The goal is to work with existing resources in education systems to ensure sustainability of the work over the long term, to seek additional funds for special projects, and for the resources to be open to all educators regardless of location. The aim is to have a credible evidence base from which all the contributors can also learn, not only about the value of digital technologies in learning but in many other fields where there is detailed research into teaching and learning.

The expected outcomes are:

- Trends in student attainment that can be directly related to new pedagogic practice: specifically through improved practice in differentiation supported through providing just-in-time access to research-based knowledge for teachers, newly qualified teachers (NQTs), student teachers, learners and their parents and developers;
- Increase in the numbers of teachers and teacher educators using and collaborating in building evidence based practice specifically demonstrated through online work and involvement;
- Engagement with the evidence base from the beginning of their training by student teachers;
- Positive involvement from those who are already working in this area, specifically demonstrated through user surveys.

[T]eachers in digital technologies at pre-university level (K-12) as well as at university and college level can all make their research international and scalable in order to influence their governments about what works in computer education

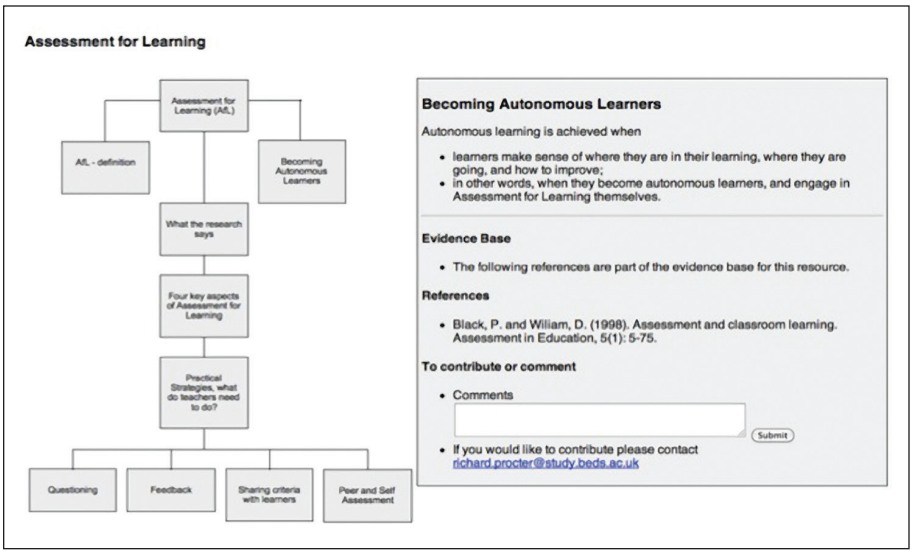

Figure 8. MESH – Mapping Education Specialist knowHow – a pathway on Assessment for Learning.

In fact, we believe that teachers in digital technologies at pre-university level (K-12) as well as at university and college level can all make their research international and scalable in order to influence their governments about what works in computer education.

Educators and academics may not have the longevity of the British Queen, but nevertheless professionals in education do have more longevity than governments and, therefore, are likely to have more knowledge about education than merely having attended a school in their youth. In the century of the internet, we now have evidence that professionals should not be dependent on political favor to maintain repositories of research findings and

resources that, in the long terms can have global impact on educational achievement. Where do you stand on these issues about computing in schools? How do you deal with politicians in your country? I'd like to hear…

For more information about how to join or start a collaborative MESH pathway email Christina@mirandanet.ac.uk. **Ir**

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