THE EDUCATION TECHNOLOGY ASSOCIATION

Advancing Education *Autumn 2019*

ISBN: SSN 2050-1331

Image Credit: Unsplash

Contents

Editorial

Dear Naace Colleagues,

In these turbulent times in international politics in which populist leaders are thriving we must not imagine that education technology is immune from the impact of the policies of the incoming political party. Working with the government of countries in Africa, China, India, Eastern Europe, the Middle East and South America I have seen, at first hand, how the current political party choses to bring computers into schools to enhance their reputation for modernity – but with very different attitudes towards who should have global access and for what reason.

So in the spirit of democratic critique, some of the articles that have been submitted to Advancing Education are asking some challenging questions about the current impact of EdTech and offering some interesting solutions. But despite all the strong feelings that have emerged over politics recently this journal also presents the articles of dedicated educators who continue to improve their practice behind the scenes.

How history and politics impact on EdTEch

So, in this political vein, the first article is from Dr Bozena Mannova at the Czech Technical University in Prague: the impact of communism on history of computer development in Czechoslovakia during the Communist occupation from 1945 – 1989. She has worked closely with Naace and MirandaNet members since the Wall came down in 1989 largely with the support of the European Union. Whatever form Brexit takes, the negativity of the debate has alerted our European colleagues to the significant reduction in opportunities to collaborate and build joint knowledge and expertise as we have in the past.

Still focusing on the history of technology, Professor Rose Luckin traces the development of Artificial Intelligence (AI) from when the concept emerged in 1956. As she explains AI is already having a big impact and many are predicting the various ways in which the robots will take over the world. Drawing lessons from history and looking at the current state of play she suggests a new model of intelligence for educators that focuses on the importance of being human.

Whilst acknowledging how technology is impacting on the workplace, Bernard Dady, an education and technology consultant, who holds a Masters in Action Research, poses some interesting questions about the lack of change in English schools reflecting how the achievements of the noughties are being eroded rather than developed.

Bernard reports a bizarre situation in English schools as we approach the year 2020. Firstly, he suggests with surprise that schooling in the UK is still dominated by mid twentieth century pedagogy. Secondly, our government is still questioning the return on investment in education technology (EdTech) both in respect of its level of use and impact on learning in schools. He contrasts these statements with the observation that outside of schooling, digital technology is utterly transformative and that its impact on learners is growing exponentially. This leads him to present two hypotheses:

- There is something seriously wrong with teacher education, especially in-service professional learning, with respect to EdTech and pedagogy; and
- We are facing an increasing failure of UK schooling to address 21st century learning skills.

In his article he puts some pieces of the 'jigsaw' on the table and explores how they might fit together to provide a solution to this conundrum.

Whereas Bernard is looking for solutions in the context of England, members of two international professional organisations have contributed an article to Advancing Education that requests the involvement of Naace in an venture that preserves our professional resources on websites globally, independent of government.

This group of colleagues from MirandaNet and MESHguides draw the attention of Naace to the vulnerability of resources stored on government websites, as they are so easily taken down by the incoming governments for reasons of cost or policy. Across the world and the centuries this kind of destruction of previous theory and practice published in books is well known, but now governments can 'burn the books' without the smell. So in this article our colleagues point out that in the early days of the development of internet hosted resources for teachers, a number of governments invested heavily in online CPD resources (EdNA in Australia; the QCDA, TDA, BECTA, DFE resources in England). Teachers then found changes of government meant resources were taken offline. Colleagues in Sweden and Scotland have reported similar actions. Not only is this a significant waste of government funds but curricula were built around the resources, and not just in the originating countries. South African colleagues reported that UK government-funded National Curriculum resources which they had been using vanished overnight with no warning. A lesson for the education sector is that where governments want resources developed the resulting resources need to be protected from destruction. This group of colleagues invite Naace members to join the campaign.

Good practice

Meanwhile our colleagues remain committed and inventive in the classroom. Dr Elizabeth Hidson, now a senior lecturer at the University of Sunderland, provides practical advice for schools considering implementing video-enhanced observation. Naace members who are using video-enhanced observation of lessons will be interested to know that research from Elizabeth Hidson, carried out when she worked at Newcastle University, indicates that this approach can be very effective in improving practice. But she is clear that it should be introduced strategically so that there is no suspicion of surveillance amongst the staff, and with due regard to data protection and security. This research was funded by the European Union.

Dr Helen Caldwell, Northampton University, quotes from her book about algorithms and algorithmic thinking that are, as she explains, central to learning about computing. However, she knows that, unfortunately, an algorithm, as a thing itself, can be rather abstract; it can be difficult for students to understand what the algorithm is doing and how the execution of the algorithm leads to the desired end result. She offers some strategies to help students see how an algorithm works on a particular problem.

Finally, a joyful piece from Ian Rae, a teacher in early years and musician, about how his free resources draw on the power of song in learning. We know that music, poetry and memory are very closely related. On the internet there are numerous examples of research into how music can greatly accelerate the learning process in languages and, in fact, retention. In some experiments using learning through songs has been twice as effective as learning "by rote". So Ian has designed some resources for younger pupils that make learning facts fruitful and fun.

So let's hope we can find more to sing about in 2020! The first chance to meet up will be at the Naace stand at BETT20 22nd to 25th January - see you there.

Yours sincerely,

Dr Christina Preston

Associate Professor of Education, DMU: Naace Board of Management: Founder of MirandaNet Fellowship: Outgoing chair of Technology, Pedagogy Education Association. By the way, BECTA research has been reassembled here https://mirandanet.ac.uk/becta-reassembled/   Please send me any other caches you have of resources that were removed from the public domain so we can restore them. christina@mirandanet.ac.uk

The impact of communism on the history of computer development in Eastern Europe.

Dr Bozena Mannova, Czech Technical University, in Prague

I first attended a Naace conference in Brighton in 1997. We do not have any sea coasts in the Czech Republic so despite the rain and the wind I remember standing at the edge of the sea and marvelling at the height of the waves.

After the Wall came down in 1989 I had been attending as many conferences as I could in Western Europe because, as a computer scientist, I knew that we were far behind. I also knew that in England there were many women in education technology. In my Computer Engineering department at the Czech Technical University in Prague I was one of only two women in a department of ninety men. In this context I heard Professor Christina Preston, who is on the Naace Board of Management, speak about Digital Literacy. We have been sharing theory and practice ever since as in communist times Digital Literacy was not on the syllabus (Preston, Lengel and Mannova 2004).

In particular, my contacts with members of the UK professional organisations, Naace and the MirandaNet Fellowship, often funded by the European Union, have been very important in another role which was working on the syllabus for teaching IT in Czech High schools with the government, as well as the practical teaching of Computer Science in Arabska School, Prague 6. I was interested in the British approach in the Information and Communications Technology curriculum, and I was active in raising teachers' awareness of the value of Computer Science in the UK in the 1990s when a national professional development programme was introduced for all teachers in England and Wales - 1999-2003 (Preston 2004).

Naace members have an interest in the history of computers and, indeed, many have lived through the introduction of major developments. So, in the article that follows I describe the history of computer technology in Czechoslovakia in the years 1945 – 1989, for members who are old enough to compare their experience with mine, when we had no access to countries outside the Communist bloc. This history is also interesting as a precursor to the Czech membership of the European Union in 2004. We have benefitted hugely from this co-operation and are very sad at the proposed withdrawal of the UK.

In this article I have described significant projects but also tried to capture the problems of computer technology in Czechoslovakia at that time and what level of technology was available. In conclusion, I try to evaluate the losses and benefits of the described situation.

Computers developed in Czechoslovakia since 1945

The beginning of the development and production of computers in Czechoslovakia dates back to 1945, but the many difficulties caused by social and economic changes after World War II had to be overcome. Antonín Svoboda, a computer expert who had returned from the USA, had been largely responsible for the development of computers in Czechoslovakia before the war. In 1950, work began on the project of the first Czechoslovak relay computer and, after seven years, it was put into trial operation. This long period of development was caused by the state of the Czechoslovak economy, namely the lack of components and their high failure rate as well as a lack of experienced workers.

The first Czechoslovak computer was named SAPO. His successor was the computer E1, which was completed in 1961. E1 was followed by an experimental computer MP10, which had control logic still based on relays, but in the arithmetic unit the first semiconductors were used. All these computers suffered from failures and backwardness as the first computer SAPO did, and their main problem was the lack of quality components.

At that time, it was already clear that the relay computers had no great future, but the experience gained by developers was evaluated in the coming years. In 1956, the development of a large, universal computer named EPOS was designed to process mass data. Many previous computer development activities were not initiated by the state, so they were just short-lived research projects: EPOS was developed as a state project.

In the 1950s, computing technology was already important in the world. Even in the countries of the Soviet Bloc, the state was interested in economic and military reasons. The obvious result in Western countries was an embargo on the export of new technologies to the Communist countries of Europe. This meant we had to develop our own technologies in Czechoslovakia, which was very difficult because of the inefficient planning of our economy. The development was also adversely affected by the emigration of Antonín Svoboda with a number of collaborators back to the USA in 1964. They were frustrated by their lack of progress under Communism.

Cooperation in computer development across Soviet Bloc countries after 1968

With computer technology lagging behind in the socialist states and the very small possibility of importing technology from developed countries due to the US embargo, we developed a project of the Unified System of Electronic Computers (Jednotny system elektronickych pocitacu - JSEP) in the eastern European countries. From 1975 to 1974, the development and production of five types of computers named the JSEP sequence was launched. In 1974, the Small Electronic Computer System (SMEP) was added to the joint program. Within a few years, we managed to create a modular system of technical and programmatic resources, which, with the mutual cooperation of the participating countries, would guarantee cheaper mass production. All of the JSEP computers developed in Czechoslovakia differed significantly from the other computers in the type of software. While all other Council for Mutual Economic Assistance (COMECON) countries literally copied the IBM operating system prototyping systems, often bordering or outperforming IBM, Czechoslovak computers had their own operating systems. These were intended to be high-quality operating systems, fully compatible with IBM, based on the IBM Principles of Operation. However, the result of all these activities was not excellence. The computers produced were seriously malfunctioning and the copied components were not of good quality.

In the light of this situation, the JSEP project focused on the development of third generation computers and was called JSEP1 running between 1968 and 1974. Later the project was extended to the three-and-a-half generations of JSEP2 and JSEP3 fourth generation computers were developed. The research work was conducted by an intergovernmental commission. A clear effort was made to achieve technical and program compatibility with the IBM 360, which became a model for development. It was the first attempt to jointly design sets of computers and accessories on such a wide scale and this was clearly reflected in the development results. In many cases, the deadlines were met, but at the expense of good construction and other details. The exact technical standard was not predetermined and was only developed subsequently with individual computers. Individual design and technological solutions differed from country to country. Fortunately, we managed to solve the mutual compatibility of individual devices, which enabled their interconnection, unified programming, installation and maintenance.

This change in computer technology caused a number of difficulties in the COMECON states, as many countries had had to withdraw from the development and production of their own branded computers and move on to the development of the computers assigned to them by the socialist block. To overcome these difficulties, about 150 organisations and businesses, 30,000 scientists and technicians and 300,000 workers were involved in meeting the project requirements in the COMECON Member States.

From the JSEP1 series, the EC 1021 computer was created in the Industrial Automation Plant in Czechoslovakia, whose development was implemented in VÚMS Prague. Around 1973 a total of 300 pieces were produced. Control memories began to be manufactured with integrated circuits, increasing operational reliability by a factor of 20 over the original design. The control panel was equipped with an electric typewriter with a contactless keyboard and a typewriter Consul 256. The rationalisation of the instructions resulted in a 40% increase in working speed.

EC1201

The EC1021 was a medium-sized computer, requiring a 150 m2 air-conditioned hall. The ambient temperature had to be kept between 20 and 23 ° C. It was a universal mainframe eight-bit computer with a disk-oriented MOS system designed especially for the processing of mass data. The use of fast scratch and control memory contributed to increased performance. The compact design and the introduction of some modern manufacturing technologies contributed to increasing computer reliability. There was a punch card reader at the computer input, and a line printer at the output. The memory capacity was 64 KB. The speed of the modernised version was about 5 × 105 operations / sec. Nine track magnetic tapes were the main carrier for permanent data storage and program backup. The tape capacity was 10 MB at a tape length of 1,200 feet.

Similarly to the development of standard JSEP computers, in 1974 the COMECON countries joined the Small Electronic Computer System Development Program (SMEP) to overcome delays in small computers. Within a few years, we managed to create a modular system of technical and software resources in the category of minicomputers and microcomputers, which was supposed to ensure cheaper mass production in co-operation with the participating states. The development was managed by a board of chief designers, the main workplace of SMEP in Czechoslovakia became the Research Institute of Computer Science in Žilina. The production of peripherals was ensured by the Computer Technology Plant in Banská Bystrica and Námestovo. The SM3-20 computer with 56 KB semiconductor memory and 300,000 operations per sec operating speed was designed for scientific computing, data collection and preprocessing. In the most common combination, SM3-20 worked with disk and tape memory, a point printer, a screen terminal and punched tape inputs and outputs.

Personal Computers

In the second half of the 1980s, microcomputers and personal computers began to be used in Czechoslovakia. Import was limited and again domestic substitutes were produced. Production of the first home microcomputers in Czechoslovakia began in 1983: PMD-85 was produced in Tesla Piešťany and IQ 151 from ZPA Nový Bor.

IQ151

The IQ 151 was the most widespread microcomputer for schools. Another interesting experiment was the 8bit microcomputer, TNSS, which was produced in the Agricultural Cooperative JZD Slušovice and was used in the commercial area. Also worth mentioning is Didaktik Gamma, which was compatible with the ZX Spectrum.

EC1201

TNS Microcomputer

The Czech state has tried to catch up with many years of delays in this area by importing several tens of thousands of the cheapest types of home computers, especially ZX Spectrum and Atari. A few other computer types were available from the foreign trade company TUZEX. Surveys in 1985 showed that 100,000 computers were already in our homes at the time.

We were beginning to rebuild the reputation we had for outstanding technological innovation before the Second World War.

Evaluating the impact

What impact did the development and production of computer technology have on our people? We could look at these early activities as totally useless because we did not manage to catch up with the West and our results were not good. The computers we produced in this period after the Second World War were unreliable and often even unusable.

The implementation of a brand new component base, new manufacturing technologies and new equipment required broad cooperation from many companies from different manufacturing sectors. However, this cooperation was largely absent until 1989 because manufacturing companies had no desire to change production programmes, because of the level of risk. Over these years of the socialist system when inflexible state planning dominated, innovation was difficult to achieve.

However, when the computer market was opened after 1989, the experience gained was important in our determination to work with the newly purchased computer technology. The post war research and development of computer technology has contributed to the fact that the level of knowledge in this field was very high in Czechoslovakia. As a result, our experts were able to adapt to the influx of new products more quickly. The development of computer technology in the field of architecture and software was not in Czechoslovakia a literal copy of Western designs, as was the case in other eastern countries. Especially in the field of operating systems and application programs, a number of original solutions were created in Czechoslovakia that had some influence. The development of computers has contributed to the introduction of other new technologies, which have been widely used outside the computer technology field.

Acknowledgement

This work was carried out within the framework of the project of the Ministry of Culture of the Czech Republic - NAKI II number 18P02OVV052.

References

Preston. C. (2004) Teachers' and Trainers' Perspectives Researching the outcomes of the New Opportunities Fund (NOF) ICT Teacher Training TTA/MirandaNet http://www.mirandanet.org.uk/tta/

Preston, C. Lengel, L and Mannova B. (2004) Building communities of practice in "New" Europe. A chapter in A Brown, and N Davis (eds): Digital Technology, Communities and Education: World Year Book of Education – 2004 Routledge Falmer

Zelený, J., & Mannová, B. (2006). Historie výpočetní techniky. Scientia.

MirandaNet Fellowship mirandanet.ac.uk

Moving Human Intelligence Forward with AI.

Professor Rose Luckin, Institute of Education, UCL EDUCATE

Artificial Intelligence (AI) is not just the stuff of movies and science fiction, it is here now and many of us use it every day. For example, when we search on the internet, use a voice activated assistant like Apple's Siri or Amazon's Alexa, or when we use an e-passport gate at the airport. AI is here, it is not going away and it will impact on education.

A basic definition of AI is one that describes it as 'technology that is capable of actions and behaviours that require intelligence when done by humans'. The desire to create machines in our own image is not new—we have, for example, been keen on creating mechanical 'human' automata for centuries. However, the concept of AI was really born 63 years ago in September 1956 when 10 scientists at Dartmouth College in New Hampshire spent the summer working to create AI.

Following on from this there were some early successes. For example, expert systems that were used for tasks such as diagnosis in medicine. These systems were built from a series of rules through which the symptoms a patient presented could be matched to potential diseases or causes, so enabling the doctor, aided by their AI, to make a decision about treatment. These systems were relatively successful, but they were limited because they could not learn. All of the knowledge that these expert systems could use to make decisions had to be written at the time the computer program was created. If new information was discovered about a particular disease or its symptoms, then in order for it to be encompassed by the expert system, its rule-base had to be changed. In the 1980s and 90s useful systems were built, but certainly we were not anywhere near the dreams of the 1963 Dartmouth College conference.

Then, in March 2016 came a game-changing breakthrough. A breakthrough that was based on many years of research. A breakthrough that was made when Google Deepmind produced the AI system called AlphaGo that beat Lee Sedol, the world 'Go' champion. This was an amazing feat—a feat that could seem like magic. While many of the techniques behind these machine-learning algorithms are very sophisticated, these systems are not magic and they do have their limitations. Smart as AlphaGo is, the real breakthrough was due to a combination that one might describe as a perfect storm. This perfect storm arose due to the combination of our ability to capture huge amounts of data, with the development of very sophisticated AI machine-learning algorithms that can process this data, plus affordable computing power and memory. When combined, these three factors provided us with the ability to produce a system that could beat the world Go champion.

Each of the elements in that perfect storm: the data, the sophisticated AI algorithms and the computing power and memory, are important. They are the power that enables us to build AI that can learn and improve. But just like any other technology that we might use in education, we need to use AI judiciously and we need to make sure that it is addressing the educational needs of our institutions, teachers and learners.

AI as EdTech

We can certainly use AI to tackle some of the big educational challenges and to support teaching and learning.

For example, companies like alelo (www.alelo.com) build educational technologies that use AI to help students to learn across a range of subjects, including learning English. London-based CENTURY Tech are another AI company that have developed a machine-learning platform that can personalise learning to the needs of individual students across curriculum areas to help them achieve their best. A further reality is that, in addition to being able to build intelligent platforms, such as Century, we can build intelligent tutors (such as those produced by Carnegie

Learning) that can provide individual instruction to students in a specific subject area. These systems are extremely successful; not as successful as a human teacher who is teaching another human on a one-to-one basis, but the AI can, when well-designed, be as effective as a teacher teaching a whole class of students.

In addition to intelligent platforms and intelligent tutoring systems, there are many intelligent recommendation systems that can help teachers to identify the best resources for their students to use, and that help learners identify exactly what materials are most suitable for them at any particular moment in time (see for example, www.bibblio.com and www.teachpitch.com.

It is not just when learning particular areas of the curriculum that AI can make a big difference. AI can also help us to build our cognitive fitness, so that we have good executive functioning capabilities, can pay attention when needed, remember what we learn, and focus on what needs to be done. This system, called MyCognition (www.mycognition.com), for example, enables each person who uses it to complete a personal assessment of their cognitive fitness and then train themselves using a game called Aquasnap. AI helps Aquasnap to individualise training according to the needs of the particular person who is playing.

Specialist knowledge required

However, there are more ways that AI impacts on education than through the way we use it to support teaching and learning. A second way that AI impacts upon education is in the way that we need to help people understand what AI is, so that they can use it safely and efficiently. We need everyone to have a basic understanding of AI, so that they have the skills and abilities to work and live in an AI-enhanced world. This is not coding, this is understanding why data is important to AI and what AI can and cannot achieve. We also need everyone to understand the basics of ethics, but we need a small percentage of the population to understand a great deal more about this, so that they can take responsibility for the regulatory frameworks that will be necessary to try and ensure that ethical AI is what we build and use. And then there is the real technical understanding of AI that we need to build the Next Generation of AI system. Again, a small percentage of the population will need this kind of expert subject knowledge.

AI and the fourth industrial revolution

Finally, we come to the third category of ways in which AI impacts upon education, and that is the implications that AI is bringing to the workplace and our lives through what is sometimes called the Fourth Industrial Revolution. These implications, that mean the automation of some jobs and the changes in some jobs, because AI can do some of what humans have been doing, bring the need for changes to our education systems.

Many people and organisations, including the World Education Forum, are telling us that we are now entering the Fourth Industrial Revolution—the time when many factors across the globe, including the way that AI is powering workplace automation, are changing the workplace and our lives forever. Not everyone is as optimistic, and there are an increasing number of reports that consider the consequences for jobs of the increased automation taking place in the workplace. A report called 'Will robots really steal our jobs?' published in 2018 by PWC illustrates that transportation and storage appear to be the areas of the economy where most job losses will occur. Education will be the least prone to automation. We could interpret that as meaning that education will not change. However, I believe that education will change dramatically. It will change as we use more AI, and it will change as what and how we teach changes in order to ensure that our students can prosper in an AI-augmented world. Reports such as this also make it perfectly clear that the impact of AI, automation and the Fourth Industrial Revolution will not be felt by everyone equally. Of course, those with higher education levels will be least vulnerable when it comes to automation and job loss. We therefore need to provide particular support for those with lower levels of education.

Personally, I do not think all these reports are that useful, interesting as they are. We human beings are rather poor at prediction and the differences of opinion across the different reports indicate the complexity of predicting anything in such fast-changing circumstances. Trying to work out what to do for the best in a changing world is a little bit like driving a car in dense fog along a road that you don't know. In these circumstances, a map about the road ahead has limited use. What we really need is to know that we have a car that is well-equipped, we have brakes that work, lights that work. We want to be warm and we want to know that as a driver, we understand how to operate the car, we understand the rules of the road, we have eyesight that's good enough to help us to see in the limited visibility ahead and we can hear what is going on, so that we can respond to impending danger that may indicate its presence by being noisy—a huge truck thundering towards us, for example.

A new model of intelligence

So, what's the equivalent of this good car and good driver when it comes to what we need in order to find our way through the fog of uncertainty around the Fourth Industrial Revolution? This is a subject that I have studied and written about quite a lot and a subject that is covered in the book 'Machine Learning and Human Intelligence: The Future of Education' in the 21st century. Here I can only skim over the way that I unpack the intelligence that we need human beings to develop if we are to find our way through this foggy landscape. This is the intelligence that can help us to cope with the uncertainty and it can help us to differentiate ourselves from AI systems. It is an interwoven model of intelligence that has seven interacting elements:

1. The first element of this interwoven intelligence is: interdisciplinary academic intelligence. This is the stuff that is part of many education systems at the moment. However, rather than considering it through individual subject areas as we do now, we need to consider it in an interdisciplinary manner. Complex problems are rarely solved through single disciplinary expertise, they require multiple experts to work together. The world is now full of complex problems and we need to educate people to be able to tackle these complex problems effectively. We therefore need to help our students see the relationships between different disciplines. We need them to be able to work with individuals who have different subject expertise and to synthesise across these disciplines to solve complex problems.

2. Secondly, we need to help our students understand what knowledge is; where it comes from, how we identify which evidence is sound enough to justify our belief that it is true. I refer to this as meta knowing, but of course we can use the terminology of epistemology and personal epistemology to describe this meta knowing.

3. The third element of our intelligence that we really need to develop in very sophisticated ways is social intelligence. It is very hard for any artificially intelligent systems to achieve social intelligence, and it is fundamental to our success. We increasingly need to collaborate in order to solve the kinds of complex problems that we will be faced with on a daily basis.

4. Fourthly, we need to develop our meta cognitive intelligence. This is the intelligence that helps us to understand what we need to know to understand how we learn, how we can control our mental processes and how we can maintain our focus and spot when our attention is skidding away from what it is we are trying to learn. These metacognitive processes are fundamental to sophisticated intelligence and again, they are hard for AI to achieve.

5. The fifth element of intelligence we must consider is our meta emotional intelligence. This is what makes us human. We need to understand the subjective emotional experiences we sense and we need to understand the emotional perspectives of the others with whom we interact in the world. This emotional intelligence is also hard for AI. AI can simulate some of this, but it cannot actually feel and experience these emotions.

6. We also need to recognise the importance of our physical presence in the world and the different environments with which we interact. We as humans beings, are very good at working out how to interact intelligently in multiple different environments. This meta contextual intelligence is something at which we can excel, and something that AI has great trouble with. Context here means more than simply physical location. It means location, It also means the people with whom we interact, the resources that are available to us and the subject areas that we need to acquire and apply in order to achieve our goal.
7. If we can build these interwoven elements of our human intelligence, then we can really achieve what's important for the future of learning and that is: accurate perceived self-efficacy. By this I mean that we can see how we can be effective at achieving a particular goal, at identifying what that goal consists of, identifying what aspects of that goal we believe we can achieve now, what aspects we need to learn about and train ourselves to achieve. In order to be effective, we must understand, then apply all the elements of intelligence so that we can work across and between multiple disciplines with other people with effective control and understanding of our mental and emotional processes.

Let me take a moment to stress something important here. This is about intelligence. It is not about 21st century skills or so-called soft skills. It is about something much more foundational than any skill or knowledge. It is about our human intelligence. I also want to emphasise that we can measure the development of our intelligence across all seven elements. They can all be measured, and importantly, they can all be measured in increasingly nuanced ways through the use of AI. This enhanced and continual formative assessment of our developing intelligence will shed light on aspects of intelligence and humanity that we have not been able to evidence before. We can use our AI to help us to be more intelligent, and this is very important.

The truth of the matter is that being human is extremely important.

In summary, we can therefore say about AI in education that AI is smart, but human beings are and can be way smarter.

Acknowledgements

The full article was first published by Teaching Times, May 2019

Edtech, CPD and the Absence of Transformation.

Bernard Dady, Education and Technology Consultant
bjdeducation@btinternet.com

I find it somewhat bizarre that as we approach the year 2020:

a. Schooling in the UK is still dominated by mid twentieth century pedagogy and
b. We are still questioning the return on investment in EdTech (education technology) both in respect of its level of use and impact on learning in schools.

I have no doubt that, outside of schooling, ICT is utterly transformative and that its impact on learners is growing exponentially. This leads me to two hypotheses:

c. There is something seriously wrong with teacher education, especially in-service professional learning, with respect to Edtech and pedagogy.
d. We are facing an increasing failure of UK schooling to address 21st century learning skills.

In this article I will put some pieces of the 'jigsaw' on the table and explore how they might fit together to provide a solution to this conundrum.

21st Century Learning Skills

These have been articulated in many ways but, at time of writing, the concept of digital competences or 21st century learning skills serve to exemplify our social and economic requirements. The Curriculum for Wales (2008)[1] describes these through the Digital Competence Framework. It lists a range of skills to be developed across the curriculum and in all phases of schooling. The competences are clustered under broad themes as follows:

- **Citizenship** – what it means to be a digital citizen with the skills of contribution and critical evaluation
- **Interacting and collaborating** – understanding electronic communication and collaboration
- **Producing** – the cyclical process of planning, creating, evaluating and refining digital content
- **Data and Computational Thinking** – scientific enquiry, problem-solving and thinking skills

A second framework, actively promoted by Microsoft, is 21st Century Learning Design[2]. This originated from the Innovative Teaching and Learning (ITL) Research Project. Based on the research, 21st Century Learning Design asks teachers to: analyse and 'code' learning activities to see how deeply they integrate 21st century skills; collaborate in designing new learning activities that provide deeper 21st century skills; examine the impact of these learning activities on students' work and use ICT as part of the process.

At the heart of the methodology are the learning activity rubrics:

- Collaboration
- Skilled Communication
- Knowledge Construction
- Self-Regulation
- Real World Problem-Solving and Innovation

[1] https://hwb.gov.wales/curriculum-for-wales-2008/digital-competence-framework-curriculum-for-wales-2008-version/

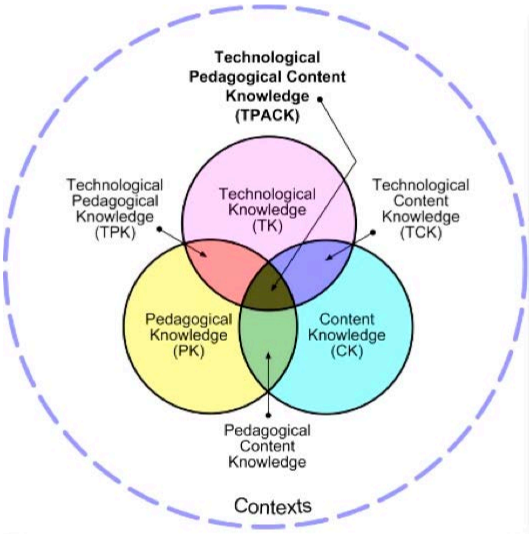
[2] https://education.microsoft.com/GetTrained/ITL-Research

- Use of ICT for Learning.

Put these two frameworks together, and blend in any other digital competence frameworks that you know of, and you quickly see that the emphasis lies not in what we teach but how we teach and the way learners learn, across the curriculum and at all stages of education.

Content, Pedagogy and Technology

This brings us to a second piece of the jigsaw. Punya Mishra and Matthew J. Koehler's 2006 TPACK framework[3], which focuses on technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) is a concise definition of why educators find it so hard to use EdTech with real purpose.



Today, the main driver for school-based learning is the syllabus or curriculum. This defines what must be taught. Consequently, content has become king. Focus on how we teach and learn is beaten into a poor second place, with development of 21st century learning skills under-developed and deep learning passed over.

Then there is the fact that most schooling in the UK is pedagogically restricted. Highly instructional and teacher led this approach is dominated by a natural conservatism, in part a consequence of teachers mirroring their own school experience, in part deficiency in pedagogic education, in part being risk averse and in part being time poor. These barriers have narrowed teaching and learning to the point where it is not possible to utilise the full potential of the available technology. This is now even more marked with the start of migration to Cloud services, with true communication and collaboration potential. Pedagogical diversification is deeply related to our capacity to use the full potential of EdTech.

Yet we have a strong tradition of project and enquiry-based learning in this country. There is a rich dialogue around problem-solving and flipped learning methodologies. We have a deep passion for creativity and an understanding of the power of collaborative learning. So why is so much student time spent watching, listening and recording?

Then there are the barriers in the technology sphere: cycles of investment and decline, with provision in many schools dated and unreliable. The frenetic pace of change in technological development makes it hard for teachers to keep up. There is a restricted vision at leadership and governance level – the chasm of 'we do not know, what we do not know'. This leads to low levels of teacher confidence, fed by the risk that EdTech will not work and lack of understanding of what is possible. Additionally, too much decision-making is driven by IT enthusiasts and not by educational strategy. Thus, device and software purchasing comes first, thought about how to use it comes after (or never in respect of the 'kit in the cupboard').

3 https://www.punyamishra.com/research/tpack/

The Centrality of Professional Learning

In July 2016 the Department for Education published *The Standard for Teachers Professional Development*[4] . In its preamble the Standard reflected some simple truths about effective teacher CPD.

Effective teacher professional development is a partnership between:

- Headteachers and other members of the leadership team;
- Teachers; and
- Providers of professional development expertise, training or consultancy.

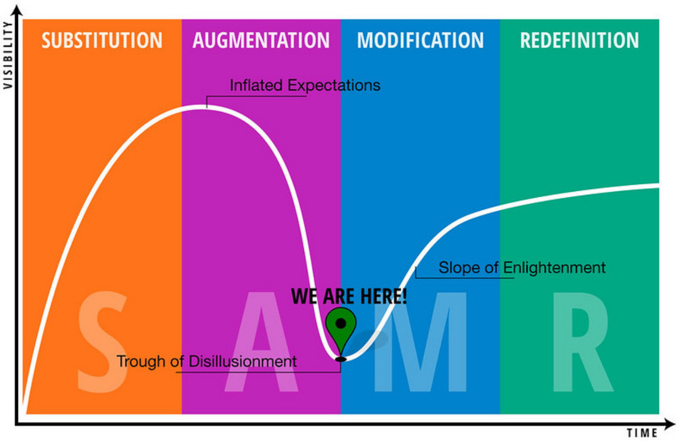
In order for this partnership to be successful:

1. Professional development should have a focus on improving and evaluating pupil outcomes.
2. Professional development should be underpinned by robust evidence and expertise.
3. Professional development should include collaboration and expert challenge.
4. Professional development programmes should be sustained over time.
5. And all this is underpinned by, and requires that:
6. Professional development must be prioritised by school leadership.

Such a simple self-assessment framework reveals consistent failings when it comes to professional development in relation to teaching, learning and EdTech. We are not doing this at all well across the system.

Our relentless focus on content-dominated subject achievement has side-tracked the profession for too long. Ofsted inspection has eaten into the confidence to take risks and narrowed the focus of professional learning. Statutory obligation and accountability have diminished the time available for experimentation and development. We are not being transformational - schooling is falling behind the learning curve. Our economy and digital lives are accelerating away and what happens in classrooms becomes less and less relevant to the information and digital age.

Fit the Jigsaw Pieces Together



If we are to drag schooling into the 21st Century and deal once and for all with questions about return on investment in technology, then we have to put the pieces of the jigsaw together and think holistically about what we teach, the way we teach it, how learners learn and how we prepare them for the future. This diagram, a fusion of Dr. Ruben Puentedura's SAMR model[5] and the Gartner Hype Cycle[6], as created by Tim Klapdor[7], speaks volumes about our current condition.

---

[4] https://www.gov.uk/government/publications/standard-for-teachers-professional-development

[5] http://hippasus.com/rrpweblog/archives/2015/10/SAMR_ABriefIntro.pdf

[6] https://www.gartner.com/en/research/methodologies/gartner-hype-cycle

[7] https://timklapdor.wordpress.com/2013/02/08/the-current-state-educational-technology/

So many UK schools are stuck in the substitution zone, with technology being used to replicate the functionality of blackboards and books. Too many teachers have started to augment practice with ICT, only to find themselves sunk into the 'trough of disillusionment' as ageing technology ceases to deliver. How many educators and institutions can truly say that they are on the 'slope of enlightenment' when it comes to teaching and learning transformed with EdTech?

In Conclusion …

In this short piece I have taken just three pieces of the educational jigsaw: redefinition of what we should be teaching; diversification of pedagogy and vision for how EdTech can transform learning outcomes. I have indicated that we are failing against our own standards for teacher professional development and, consequently, we see systemic weaknesses in applying investment in EdTech effectively.

Digital competences are as critical as literacy and numeracy. EdTech is the key tool for teaching and learning in the 21st century. Professional development is central to educational transformation. If we do not address this reality then I fear that schools will become little more than museums of industrial age education and our students will find the gap between schooling and the workplace ever harder to bridge. What then for our digital economy and the social well-being of our citizens? What then for schools?

In the classic school report vernacular, "Could do Better."

Of course, we can do better. We have the knowledge; we have the technology. We just need the will along with:

- Appropriate focus on digital competence and 21st century skills in the curriculum
- Full understanding of how the TPACK model can drive development of teaching and learning with technology
- Systematic and sustainable focus on in-service professional learning for educators
- Education-led investment in technology
- Leadership to transform schooling so that it is tuned to the digital age.

Protecting our professional knowledge: sharing resources internationally using digital tools.

Professors Marilyn Leask, Christina Preston, and Sarah Younie with Jon Audain and Richard Proctor, Members of MirandaNet Fellowship and MESHguides

Professional knowledge sharing internationally through digital tools

Overall this article is about how different professional organisations can gain strength in working together to share and safeguard our knowledge and expertise for the next generations, no matter which governments gain power. As the authors of this article, we believe strongly in the power of communities of practice. In fact, this desire to share knowledge and expertise for the greater good dates from the medieval trade guilds (Wenger 2002).

Our views that follow are the results of discussions as members of MESH (Mapping Educational Specialist knowHow - http://www.meshguides.org/ as well as the new professional organisation being established, Technology, Pedagogy and Education (tpea.ac.uk), a partnership between Information Technology in Teacher Education established in 1986 (itte.org.uk) and the MirandaNet Fellowship(mirandanet.ac.uk), established in 1992. But we also belong to a range of other edtech professional organisations like, Naace and ALT, that represent different aspects of knowledge and expertise about teaching and learning in education technology, nationally and internationally. The history of these key organisations in our field of digital innovation in education already stretches back more than thirty years and the Royal Society has reported that the government would not be facing so many challenges in Computing if they listened to the 'learned societies' (Royal Society 2017).

New ways of sharing research findings

In particular we ask our colleagues to consider new possibilities for how digital tools can be used to enable knowledge sharing online as a form of continuing professional development (CPD) for teachers, explore some of the challenges in doing so, and exemplify how such an idea works in practice through the MESH (Mapping Educational Specialist knowHow) project.

Recently some of our repositories for resources that are now kept on websites have been removed by new governments around the world before we, as professionals caught up with the danger. While the UK had extensive open online educational resources for CPD prior to 2010, the websites where they resided were closed down following a change in government. In the years that followed, the authors and a network of colleagues who belong to MESHguides consulted with teacher and teacher education colleagues about online CPD provision from countries as diverse as the USA, Thailand, Pakistan, Bhutan, Malaysia, Cameroon, the Czech Republic, New Zealand, Australia, Afghanistan, Croatia, Poland, Ecuador and South Africa. They found colleagues faced similar problems about the lack of research and lack of access to usable knowledge. There was a willingness to work together to address these problems.

Knowledge sharing in practice: The MESH (Mapping Educational Specialist knowHow) experiment

The authors of this paper have been involved in experiments with digital technologies to support lifelong teacher learning since the 1980s and have, with colleagues around the world, developed a prototype knowledge mobilisation system to address the criticisms of knowledge management in the education sector. The system is called MESH - Mapping Educational Specialist knowHow.

We also consulted with OECD and UNESCO colleagues and have found no organisation with a remit or the capacity to focus on building and making public the knowledge base underpinning educational practice. (Note: this is not the same as giving teachers open access to research articles.)

Here are some points of consensus that developed from the consultation:

- No initial training can provide teachers with the knowledge needed for teaching over a whole career. In both developed and developing countries, there appears to be a consensus around initial teacher training models - three or four years of training with concurrent teaching of pedagogy and subject content training or a 3+1 model with some countries, e.g. Finland, also requiring Masters level training (this was proposed in England in 2008). However, in times of shortages of teachers, standards for entry are usually dropped. This means that CPD provision cannot be based on assumptions about what teachers know already and supports the case for self-directed CPD to be organised. We propose integrating ITT and CPD online provision, linked with CPD points type accreditation, could provide a continuum for professional learning. Teachers who are members of the Royal Society of Biology, for example, already undertake self-directed accredited online CPD. Given the pace of change in different subject disciplines (including pedagogy, neuroscience, psychology and so on) keeping teachers up to date is a significant challenge.
- Knowledge resources need regular updating.
- A-Z lists of research summaries are needed - giving an overview of the field produced specifically for teachers - accessible at the touch of a button and regularly updated.
- Small changes in publishing practices could lead to production and updating of such research summaries.
- Other professions with similar knowledge services provide funding models educators could follow.

Challenges in a knowledge base for teaching

Our analysis is that technologies offer the teaching profession the opportunity to revolutionise the way knowledge is held and constructed 'by the profession, for the profession' but that there is a challenge here in how to guarantee quality, relevance and coverage. The authors estimate that were it to exist, a comprehensive pedagogic knowledge repository for the teaching profession (covering the teaching of key concepts in specific subjects for the whole range of learner needs) might contain thousands of entries, based on the core concepts for teaching covered in the indexes of educational texts like Capel et al.(2019) being multiplied by number of different subjects, phases, and contexts in which those concepts might be applied. Even Shulman's simple articulation of the different forms of knowledge for teaching (Shulman, 1987; Table 1) illustrates the breadth of knowledge involved in teaching.

Table 1: Forms of knowledge for teaching (developed from Schulman 1987)

General Pedagogic Knowledge	i.e. the broad principles and strategies of classroom management and organisation that apply irrespective of the subject.
Subject Content Knowledge	i.e. research based knowledge generated by specialist research units in genetics, literature etc.
Subject Pedagogic Knowledge	i.e. the knowledge of what makes for effective teaching and deep learning of concepts in specific subjects at specific ages for particular learners.
Technology Pedagogic Knowledge	i.e. the knowledge of what makes for effective teaching and deep learning of concepts in specific subjects at specific ages for particular learners.
Curriculum Knowledge	i.e. the materials and the programmes that serve as 'tools of the trade' for teachers and which ensure progression in learning over the years.
Knowledge of Learners and their Characteristics	i.e. knowledge of child development from psychology, sociology, and neuroscience.
Knowledge of Educational Contexts	i.e. cultural knowledge which impacts on schooling.
Knowledge of Educational Ends	i.e. purposes, values and philosophical and historical influences: both short and long term goals of education and of a subject.

In this context Fullan argues that 'a key obstacle in the evolution of teaching as a profession is an inadequately defined knowledge base about teaching and teacher education' (Fullan, 1993, p. 113).

The MESH experiment (Hurley 2019, Younie et al., 2019) combines online collaborative knowledge building models with 'translational research' publishing models, to create prototypes of new ways of working to provide up to the minute CPD materials. Examples have been developed with:

1. regional/local networks with university, school and local authority staff working together
2. specialist research institutes
3. professional subject associations
4. Non-Governmental Organisations (NGOs)
5. PhD supervisors and their students (via a national validating group)

As a result, we founded a knowledge mobilisation and knowledge exchange system called MESH, Mapping Educational Specialist knowHow, subsequently developed by the network to experiment with ideas around knowledge mobilisation. In 2018, an international advisory council was formed, with the colleagues from the countries above, to share knowledge across different countries. What is now called the MESH Knowledge Mobilisation System focuses on networking teachers and researchers to bring together, and keep updated syntheses, summaries and knowledge maps of existing research-based knowledge.

A sixth model - coordinating the work of expert teachers as change agents - is the next development. We argue such a network of teachers would lead to a dynamic and agile sector, able to respond rapidly to change, with change supported by research.

Online networking, supporting peer research, collaboration and scaling up of promising small-scale research is what we propose is necessary for building the pedagogic research base for CPD - for every subject area, every concept, every type of learner. But we also suggest these ways of working are incorporated into normal professional practices for nominated staff. Expecting funding from external bodies seems to rarely support sustainability as practices stop when funding stops. If enough leading educators adopt a self-improving profession stance then these ways of working might achieve the prize of a global, research-informed knowledge base for the teaching profession, which can be updated regularly and free at the point of access: the vision of the MESH international network.

Conclusions

Online CPD means that no longer is a teacher or school tied to a local provider. As long as the school has internet access or access to tools to provide offline provision, no longer does the remoteness of the school mean CPD is not available to staff. With over 80 languages able to be automatically translated via Google Translate, no longer is language of publication the major barrier it once was to accessing knowledge.

Digital technologies support teachers' open access to online research summaries, as well as networking to build a research knowledge base that teachers can access at the touch of a button. Thus, digital technologies support self-directed personal professional development. Not only could online CPD be free at the point of contact for the professionalisation of teaching, but the resources could also be open for access by parents, learners and other stakeholders.

In the scenario of ubiquitous international connectivity, the quality of the knowledge accessed through online CPD could be genuinely world-leading. We are not suggesting there are universal truths, but that, through the technology, access to world-leading knowledge is possible and that alternative viewpoints and emerging knowledge can be easily included so that a teacher can weigh up the evidence before making a decision about their practice.

However, our research indicates that no one country working alone is likely to be able to coordinate the resources necessary to realise the opportunities for online CPD. The knowledge base for teaching is just too extensive, with pockets of new knowledge being developed in research units, NGOs, research funder repositories and universities across the world.

So, what is to be done to realise the vision? Doctors and engineers do not wait for somebody external to their profession to organise the knowledge base for them: so why should teachers?

But who is to lead?

If you would like to join us in realising this vision email: enquiries@meshguides.org

Acknowledgements:

Parts of this paper are adapted with permission from:

Mannova B, Preston C and Younie S. (in press). Digital Revolution through community initiatives: the social politics of education futures. Prague. Czech Technical University.

Younie et al. (in press) Knowledge Services for a National Education Service in Hudson et al. (in press) Envisioning a New Education System. Abingdon. Routledge

References

Audain J, Leask, M and Younie (2019), S (forthcoming date?) Technology, educational research and the translational knowledge base: rethinking the role and identify of a future teaching profession.

Capel S, Leask M and Younie S (2019, 8th edition) Learning to Teach in the secondary school. Abingdon: RoutledgeTaylorFrancis.

Fullan M (1993) Change Forces: Probing the Depths of Educational Reform. Abingdon: RoutledgeFalmer.

Hurley S (2019) In conversation with the MESH Executive Board. voicEd Radio podcast. Available at: https://www.spreaker.com/episode/18295429 (accessed on 17 June 2019).

OECD (2009) Creating effective teaching and learning environments: the first results from the TALIS survey. OECD Paris. http://www.oecd.org/edu/school/43023606.pdf

Royal Society (2017) After the Reboot – Computing Education in UK Schools https://royalsociety.org/-/media/policy/projects/computing-education/computing-education-report-summary.pdf
Shulman, L., (1987) as summarised in Capel, Leask and Younie (2019).

Younie S, Audain J, Eloff I, Leask M, Procter R and Shelton C (2019) 'Mobilising Knowledge through Global Partnerships to Support Research-informed Teaching: Five Models for Translational Research', Journal of Education for Teaching: International Research and Pedagogy, Special Issue on 'Perspectives on Evidence-based Knowledge for Teachers: acquisition, mobilisation and utilisation'. Available at: https://doi.org/10.1080/02607476.2018.1516348 (accessed on 17 June 2019)

Other contributors:

Jon Audain, Institute of Education, University of Winchester, UK, Christina Preston, Naace and MirandaNet Fellowship Richard Procter, De Montfort University, UK, Sarah Younie, De Montfort University, UK

Correspondence to Marilyn Leask, Education Futures Charity, UK marilyn.leask@icloud.com

PRACTICE

Literally stepping through algorithms: visualising algorithms with sorting networks.

Dr Helen Caldwell, Northampton University
helen.caldwell@northampton.ac.uk

Algorithms and algorithmic thinking are central to learning about computing. Unfortunately, an algorithm, as a thing itself, can be rather abstract; it can be difficult for students to understand what the algorithm is doing and how the execution of the algorithm leads to the desired end result. Students often need some way of seeing how an algorithm works on a particular problem.

There are several ways of doing this. Dry-running algorithms with pen and paper works in some cases. More complex algorithms benefit from other visualisations, particularly animations. Network algorithms are well suited to this, but the most common visualisations are for sorting algorithms. The animations range from shuffling bars, to sounds, and even Hungarian folk dancers! While these visualisations are good at showing how the algorithm operates, the student still has to keep in mind both the algorithm's specification and its behaviour, including the values of any variables used to keep track of where execution is in the algorithm.

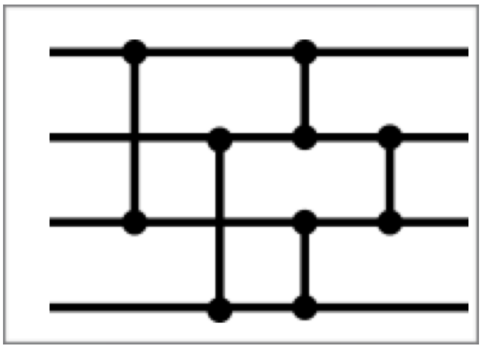


Figure 1: A four-element sorting network. Items to be sorted enter at the left. Vertical lines show comparisons and possible swaps. When the items emerge from the right, they are in sorted order, smallest at the top.

Sorting networks do a lot to address this problem. A sorting network is an executable visualisation of an algorithm. *Figure 1.* shows a sorting network and *Figure 2.* shows how one works in practice. The objects to be sorted enter the network on the left, one on each horizontal line. The vertical bars show when two objects are compared; if they are out of order, they are swapped so the smallest is at the top of the vertical bar. When the objects leave the sorting network on the right, they are in order, top to bottom. Sorting networks can be any size, but become progressively larger and more complex the more items they sort. *Figure 3.* shows a sorting network for eight items.

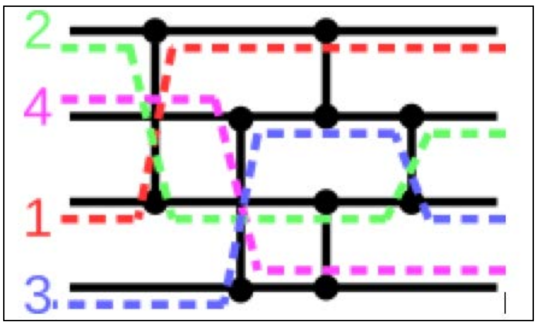


Figure 2: An example of a sorting network in action.

Sorting networks unplugged

Sorting networks work as an "unplugged" activity, where students move through a physical sorting network. It makes a good group activity, where the students become the items being sorted. We have made large sorting networks from coloured masking tape on the floor of a room (figures 4 and 5), with people holding large playing cards as the items to be sorted. (Coloured masking tape can be bought in any hardware store and we bought a cheap pack of giant playing cards on eBay.) In this presentation, students literally step through the algorithm, as the algorithm progresses.

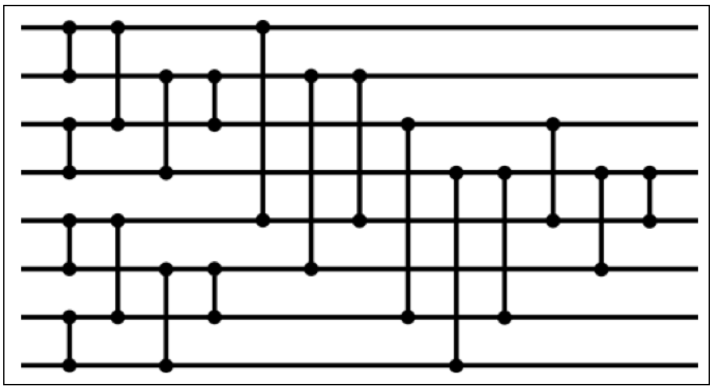


Figure 3: an eight-item sorting network

Figure 4: an six-item sorting network laid out on the floor

Figure 5: Another view of a six-item sorting network.

The instructions for the participants are simple. People start in an arbitrary order at the start of the network, then walk forwards along their line until they reach a junction with a comparison link (we marked these with crosses). There they wait until they see another person waiting at the other end of the comparator. The two people compare their cards and swap if necessary. (We found it helpful to label one side of the room "small" and the other "large" to remind people of the order when comparing). Then, both people move forward until the next comparison link. (You can do swaps either by people swapping cards or, more fun, by walking along the comparison lines.) Figure 6 shows this in action. When people reach the end of the network, they should be sorted. if something goes wrong and the output isn't sorted, ask people to walk backwards until they find a comparison in the wrong order, fix it, then run the algorithm again. This brings out the computational thinking skill of debugging.

Figure 6: People being sorted by a sorting network

Computational thinking with sorting networks

While having people run through a sorting network is a fun activity in itself, it doesn't explore or develop much computational thinking. However, it can be the basis of some work in this area. (CS Unplugged has a good resource on sorting networks with further ideas than given here.)

One thing students can consider is how they can know that the network works in every case, which means they need to consider how many ways there are of ordering the inputs, which feeds into ideas of program validation and testing. They may ask questions about whether the sorting network will work if the items are to be sorted in reverse order, or if the sorting network will sort some objects if they're fed in at the right and come out at the left.

They may also consider what the network should do when two or more items have the same values to be sorted, by introducing the idea of stable and unstable sorts. The nature of the sorting network also allows a teacher to draw out notions of parallel execution. For instance, in the eight-item sorting network, each of the the first comparisons can be done simultaneously with at least one other. This can reduce the time taken to traverse the network. This is exploited in reality in GPUs, where the parallel, one-way pipelines of sorting networks are a good fit for the parallel structure of a GPU.

Making new networks

One of the more immediately accessible exercises with sorting networks is having students build their own networks of different sizes. At first, this is a challenge, but once people know a "trick" they can easily develop reasonably small (though not necessarily optimal) networks of any size.

A two-item sorting network is trivial: it has a single comparison (figure 7). A three-item network can be built from this: first, do sufficient swaps to move the largest item to the bottom line, then sort the remaining two items. This is shown in figure 8. The first two swaps move the largest item, but the other two items could be an any order afterwards. The final swap puts them in order.

A four-item network is built from a three-item network in the same way. First, do three swaps to move the largest item to the bottom, then use the existing three-item network to sort the rest. Larger networks can be built up in the same way. students can make and test their own networks this way, gaining an understanding of how to decompose a problem into smaller subtasks. In fact, this way of building up sorting networks allows you to sneak in recursion in an easy-to-swallow form!

Again, students can use this basis to explore concepts such as the number of comparisons needed for each size sorting network, and the "depth" of the network (how many comparisons an item must go through). These can be used to prompt connections to series and Pascal's triangle and back to counting combinations.

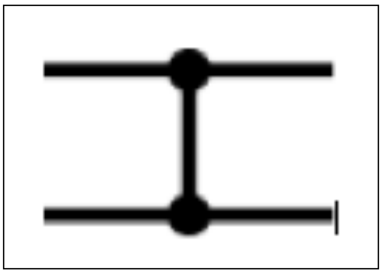


Figure 7: A two item sorting network,

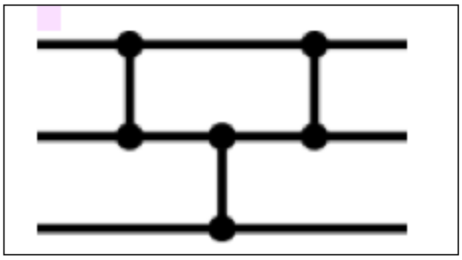


Figure 8: A three item sorting network

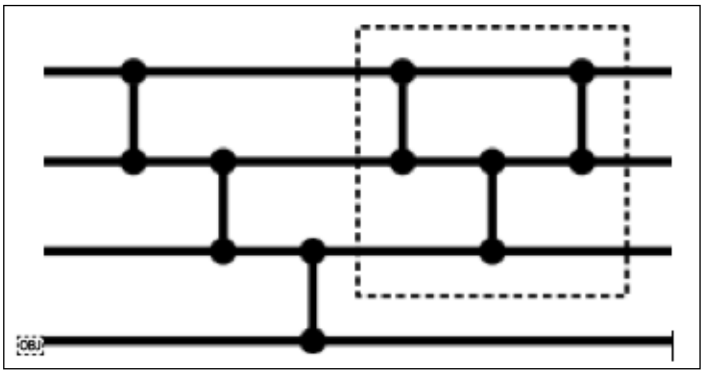


Figure 9: Video-enhanced observation incorporated into PGCE teaching practice

This approach to building up the sorting network is an example of a selection sort: the network selects the largest item and puts it in the correct place, then selects the next largest item and puts it in place, and so on. You can also show insertion sorts the same way: first, sort the n-1 items, then do sufficient swaps to put the last item in its place. This leads to the same networks as selection sorts, showing that they have the same worst-case complexity. Bubble sorts also give similar sorting networks, especially if you include the trick of not sorting the guaranteed largest items after each pass.

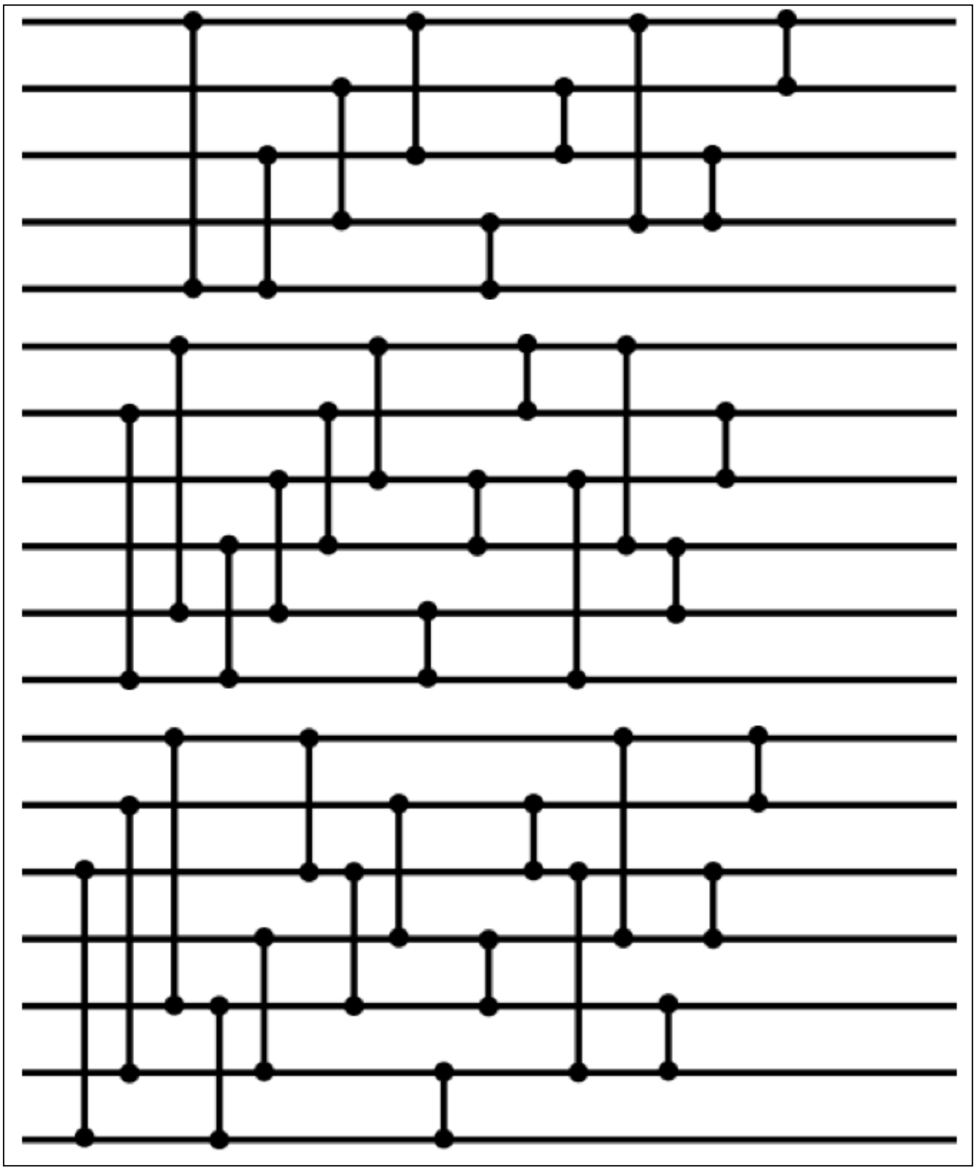
Unfortunately, while it's easy to explain, this approach doesn't lead to the smallest possible sorting networks, especially for larger networks. For instance, the four-wire network in figure 9 has six comparators, while the four-wire network in figure 1 only needs five. An extension activity could be to ask the children to come up with other sorting networks that are still correct, but which have fewer comparisons. The wikipedia article on sorting networks lists the minimum of comparators for different numbers of items. The sorting algorithms that generate smaller sorting networks are more complex than the ones found in schools, but could make the subject of a detailed investigation or project into a particular area.

Wrapping up

Sorting networks give a good vehicle for describing algorithms in a way that is immediate and visually appealing. They allow teachers to present algorithms in ways that don't use a computer or even a pen and paper. A kinaesthetic activity can make a good change in style, especially when used with younger children.

Appendix: optimal sorting networks

It's not easy to find good examples of optimal (smallest) sorting networks at different sizes. We've put some below (for five, six, and seven inputs). The Wolfram sorting network demo tool allows you to look at other sorting networks.



Reference

Smith, N. and Caldwell, H. (2016). Literally stepping through algorithms: visualising algorithms with sorting networks. Math+Code 'Zine: Exploring math through code Vol 2, Issue 1 http://researchideas.ca/mc/stepping-through-algorithms/ Faculty of Education, Western University, Ontario, Canada

Practical advice for schools considering implementing video-enhanced observation.

Dr Elizabeth Hidson, Senior Lecturer, Faculty of Education and Society, University of Sunderland, UK

What are the questions we should ask?

I have been involved in a recent research project, led by Newcastle University, that focused on trainee teachers and teacher educators across five European countries (https://veoeuropa.com), came up with four key points for school and university leaders who are thinking of adopting video in the classroom:

- Video-enhanced observation should be discussed at a strategic level and explicitly incorporated into relevant school policies;
- A video-enhanced observation framework should be developed with clear guidelines for staff observing, being observed, and for feedback;
- A dedicated platform should underpin the secure handling of video material within the school;
- Only school-approved devices should be used to collect video data, and not teachers' personal devices.

The researchers designed the project to understand how video-enhanced observation could be used in initial teacher education, given that lesson observation can be seen as a signature pedagogy when working with trainee teachers (Shulman, 2005).

- In looking at the process of lesson observation, several key questions drove the research:
- What if lesson observations were no longer isolated 'snapshot' activities carried out behind closed doors?
- What if feedback was no longer 'given' to a trainee, but developed 'with' a trainee, acknowledging good practice and agreeing developmental priorities based on video evidence and shared reflection?

How might the use of video-enhanced observation provide a new window onto this 'signature pedagogy' of the teaching profession?

A powerful learning episode

The following example is taken from a lesson observation feedback session carried out by a school-based mentor in the UK: a secondary-school assistant principal with overall responsibility for monitoring PGCE trainee teachers in the school. Of the many interesting insights into the use of video-enhanced observation for teacher education in the project, this one stood out as a powerful learning episode for the mentor and the trainees.

Having received training on the use of the video observation app, the mentor carried out some initial video-enhanced lesson observations with her new group of trainees on their second teaching placement. She did this by undertaking her usual approach to lesson observation, but with the additional feature of recording the lesson using an iPad. Still quite new to the process, she tagged moments of interest with a 'quick tag', identifying features of the lesson she could return to for discussion with the trainee.

At the bi-weekly group meeting, the mentor had negotiated with one of the trainees to feed back to him on his lesson in front of the group of trainees, so that he would receive his feedback and they would benefit from observing the process, as well as gaining insight into their new mentor's approach.

A session vignette

The trainees were seated in a classroom facing the whiteboard, with the mentor and trainee seated at the front. The mentor had uploaded the lesson video to the online portal provided by the observation software, allowing the video to be viewed on the whiteboard. Starting with the student's entry into the classroom, the mentor commended the trainee on the way that he welcomed his students individually (in this case, a drama studio) and directed them to their places. The mentor stopped the video at a moment of interest and questioned the trainee about seating arrangements. Having discussed it with him. she turned to the group of trainees and used the episode discussion and dialogue as a teaching point for them to consider in their own practice. The mentor went through several more episodes in a similar way, engaging in dialogue with the trainee and then with the group. The mentor and trainee ended the feedback session by jointly agreeing some points for him to develop in his next sequence of lessons.

Professional vision

One of the benefits of using video with trainee teachers is the potential for the development of their professional vision: 'their ability to observe what is happening in a classroom and to make sense of it from a professional perspective' (Blomberg et al 2011, p. 1131). Inevitably, there is a learning curve in terms of software and skills and also in terms of developing the sophistication of frameworks used by the trainees. The example in extract A is that of the case study trainee exhibiting typical observee self-consciousness. In extract B, he has progressed to thinking about his practice and identifying improvements using a normative frame (Calandra and Rich, 2014).

Extract A

Mentor:	You're modelling the task really well.
Trainee:	Am I that tall?
Mentor:	Well, I don't know if you're that tall or they're that short but I think he's got really good movement around the room, would you agree

Extract B

Mentor:	What do you think you could do to improve … what do you reckon?
Trainee:	My questioning could be a bit more planned. At the minute I'm still trying to gauge how much they know about the topics so I can plan the question but now I have a better idea for next time. I'll ask more detailed questions to get more detailed answers, really.
Mentor:	Yes, and if possible, when you're questioning use children's names.

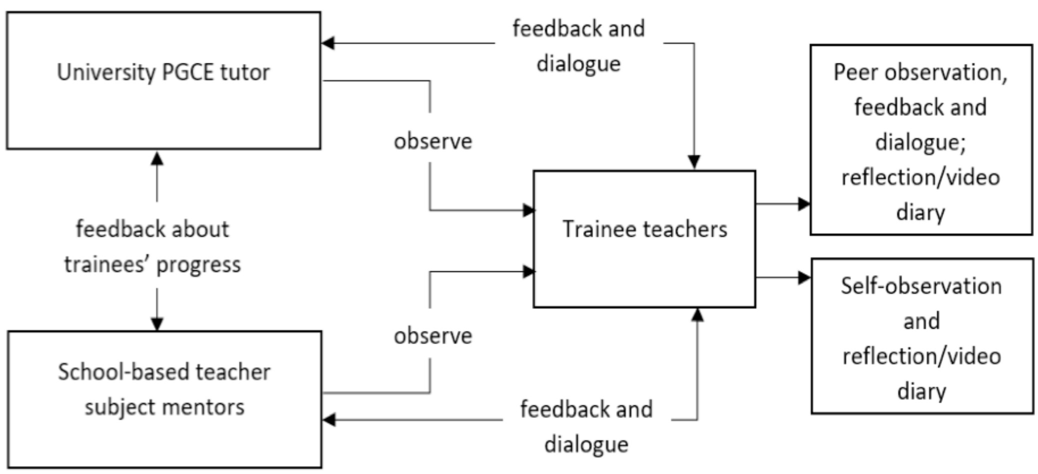


Figure 1: Video-enhanced observation incorporated into PGCE teaching practice

In EdTech terms, this classroom exchange could be interpreted as an example of a previously inconceivable task according to Puentedura's (2010) "Substitution Augmentation Modification Redefinition" (SAMR) model. Using video in the lesson observation process arguably redefines the way that this crucial developmental task is carried out. The software used for the project allowed for key moments of the lesson to be 'tagged': time-stamped with an on-screen annotation from a range of pre-selected criteria, something which could not have been done before the advent of such technology.

Conclusions

From our studies we have developed a model of the ways in which video-enhanced observation can be incorporated into PGCE teaching practice (Figure1)

We found overall that lesson observation and feedback are key to the way that we train new entrants to the profession: our 'signature pedagogy'. We found that, in the hands of experienced mentors, feedback sessions became more dialogic, more of a two-way process and ultimately more useful as a developmental activity when enhanced by the use of video.

There is pedagogic potential here that educators may want to pursue. Moving forward depends, however, on due consideration of the practicalities of adopting a video-enhanced approach to lesson observation.

References

- *Blomberg G., Stürmer K and Seidel T (2011) How pre-service teachers observe teaching on video: Effects of viewers' teaching subjects and the subject of the video. Teaching and Teacher Education 27(7): 1131-1140.*
- *Calandra B and Rich PJ (2014) Digital video for teacher education: Research and practice. London: Routledge.*
- *Shulman LS (2005) Signature Pedagogies in the Professions Daedalus 134 (3): 52-59.*
- *Puentedura RR (2010) SAMR and TPCK: Intro to advanced practice Retrieved 23 September 2018 from http://hippasus.com/resources/sweden2010/SAMR_TPCK_IntroToAdvancedPractice.pdf.*

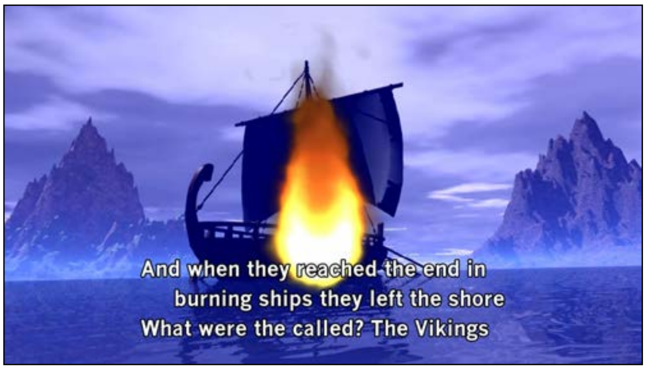
Colleagues who are interested in video-enhanced observation may also like to investigate more research by teachers here https://mirandanet.ac.uk/about-associates/associates-research/iris-connect-research-into-web-based-video-in-professional-development/

A version of this article was previously published by the Chartered College of Teaching.

The Power of Song

Ian Rae

I have never failed to be surprised by the incredible power of music to re-create memories. I only have to hear a piece of music from my past and almost immediately my mind will go back to the time when I first heard that piece of music, or I will be reminded of locations and occasions where and when I used to hear it played.



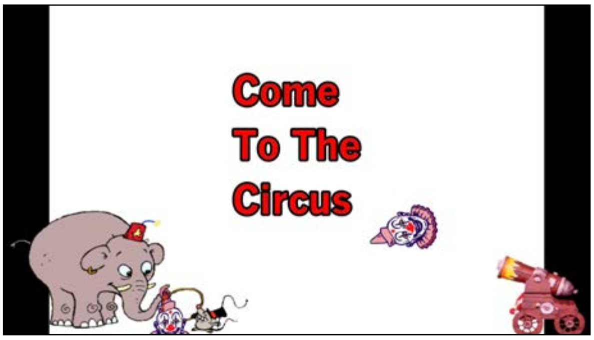
If I hear many songs from the 1950's or 1960's, in the days when I was young, I will remember all the words of the song, even though I have not heard the song for 50 years — yet I'll no doubt have trouble sometimes remembering the names of friends or the really funny joke I was told ten minutes ago!

It is a well known fact of life that music, poetry and memory are very closely related. If you search the internet you will discover numerous examples of research into how music can greatly accelerate the learning process in languages and fact retention. In some experiments using learning through songs has been twice as effective as learning "by rote".

The process of what now is commonly termed chunking — using phrases and groups of words, restricted by rhyme and metre — has been used throughout the centuries to pass on stories from father to son. The Iliad and the Odyssey are early examples of this feature. Minstrels and troubadours through the ages have been employed by kings and queens, to use music and songs to remember heroes and heroines and great events in history. If you wish to remember something, put it into song.

The ABC song, where young children learn the all the letters of the alphabet, to the tune of "Twinkle Twinkle Little Star", is probably one of the best examples of this phenomenon. On a weekly basis, I teach songs to pre-school children in a local nursery school, and ABCDEFG is one of the most popular songs, requested by the children. The younger children listen to the older children, who know the song, and ever so gradually, they pick up all the words until they can proudly sing the alphabet to the next group of young children.

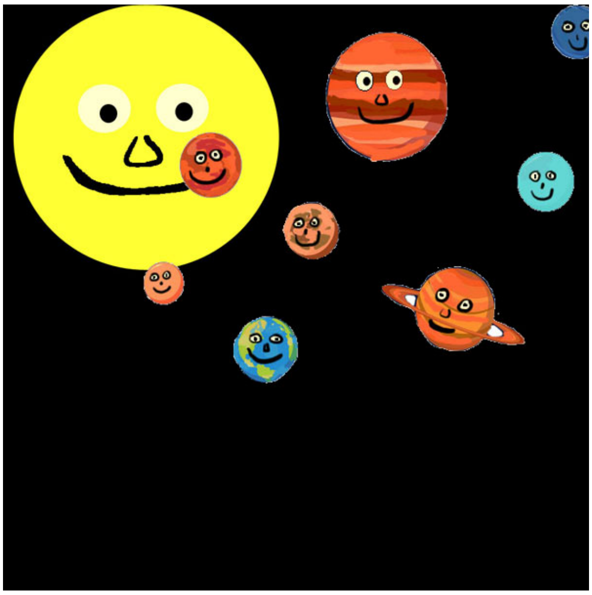
In addition, as a musician, playing music to patients suffering from dementia and Alzheimer's, I have always been astounded by the fact that many of them, even though they are unable to remember their family and friends, and what they have been doing recently, are able to remember the words of most of the songs which they listened to when they were young. Once again, there has been a huge amount of research in this area and the different sides of the brain, but the bottom line is that music can and does make a huge contribution to the learning and memory retention process.



Free Resources for young children

So, attempting to use this knowledge, over the past couple of months, I have been working to produce songs to help young children to memorise some of the facts surrounding many of the subjects within the National Curriculum Key Stage 1 and Key Stage 2 topics.

The subjects, which I have worked on, have included history subjects, like The Great Fire of London, Christopher Columbus, The Gunpowder Plot, the Vikings and Florence Nightingale, and general topics including The Pied Piper, Let's Go on Holiday, Exercise and Healthy Food and Come to the Circus



One part of the challenge of producing songs on these topics has been to encapsulate as many facts as possible within a short song. Another has been to attempt to use rhyme to reinforce the learning process.

For example in the song "London's Burning", which tells the story of the Great Fire of London, the lyrics are as follows

In sixteen hundred and sixty six

There was a fire in Pudding Lane

The houses were wooden not made with bricks

And the weather was hot with no rain

London is burning, by day and by night

For four days the flames leap all around London is burning what a terrible sight

As London is burned to the ground

London is burned to the ground

In line one, to enforce the memorisation of the date (1666) I have chosen to use the rhyme of "bricks" so that even if the children have difficulty remembering the date, they can work out that it needs to rhyme with bricks.

Again in my song about the Gunpowder Plot,

Long long ago in sixteen o five

Some men had an evil thought

To kill King James the First they did contrive
A gunpowder treason plot

In line one, to enforce the memorisation of the date (1666) I have chosen to use the rhyme of "bricks" so that even if the children have difficulty remembering the date, they can work out that it needs to rhyme with bricks.

Again in my song about the Gunpowder Plot:

Long long ago in sixteen o five Some men had an evil thought

To kill King James the First they did contrive

A gunpowder treason plot

I use the rhyme of contrive to reinforce the "five" in "Sixteen o five", so if the children are not sure of the last digit of the date the rhyme should assist in getting the correct date.

Obviously, this technique is not always suitable or available, but where it is, I attempt to use it. Early results have shown that teachers are downloading many of the songs to assist with their National Curriculum teaching, and I have been sent recordings of the songs being sung, with great gusto, in school assembly.

Obviously using song to help learning is not new, but I would hope that this method, combined with the technology incorporated in delivering it, provides another option in introducing some of the subjects within the National Curriculum.

The finale

So if you feel the need to memorise the date of the Great Fire of London, feel free to watch the video and sing along with it a few times. The proof of the Pudding Lane is in the remembering!

At the moment, the songs are all available as free resource packs for teachers and parents (and anyone else who wishes to listen or try them out) at https://www.tes.com/teaching-resources/shop/Irmamusic

There, the songs can be viewed on video, to ascertain whether the song is suitable or not, and the vocal track, backing track, lyrics and sheet music can then all be downloaded free at and from the TES website.

Events

Recommended conferences

BETT20 Excel, London 22nd - 25th January

Congratulations to Naace as the BETT20 judges have voted the Self Review Framework (SRF) as a finalist in the 'LEADERSHIP AND MANAGEMENT SOLUTIONS' category http://bettawards.com/

Naace stand is South Gallery, SC74

Naace AGM at BETT20 is Wednesday 22nd January at 1300, South Gallery, Suite Two

ICET/TPEA June 23rd/25th

Newton Park Campus, Bath Spa University

https://www.icet4u.org/upcoming_world_assembly.php

Naace is warmly invited to run a strand at this conference - enquiries christina@mirandanet.ac.uk

Conference reports

TPEA/Naace Winchester July 2019 http://tpea.ac.uk/conference/

EDUSUMMIT Canada October 2019

http://www.worldecitizens.net/edusummit-2019/

Authors

Dr. Helen Caldwell

Helen is a specialist in educational technology, teacher education and eLearning at the University of Northampton. She is an Apple Distinguished Educator and a National Executive Committee Officer for the Technology and Pedagogy in Education Association (TPEA). Her role at the University of Northampton involves working with pre-service and in-service teachers, and leading the Postgraduate Certificates in Digital Leadership and Primary Computing. Helen has considerable experience of international work and has been the research lead on nine funded projects, the most recent of which are two 3-year Erasmus+ projects on the theme of Digital Learning across Boundaries.

helen.caldwell@northampton.ac.uk

Bernard Dady (Freelance Education and Technology Consultant) MEd, BSc(Hons), PGCE (Sheffield)

Bernard is an educational strategy, design and technology professional who has over 30 years of experience in the education sector, as teacher (Sheffield), adviser/inspector (Kirklees), education action zone director (South Bradford) and local authority strategic manager (Bradford). Until early 2010 he was the BSF Programme Director for Tribal Group PLC where he worked as a consultant adviser to several major contractors on the design of new schools. This was followed by a brief period of freelance consultancy before joining Gaia Technologies PLC as Head of Education. He is now working as a freelance consultant and trainer.

Bernard has extensive experience of developing initiatives and maintaining strategic partnerships between private sector organisations and forward-thinking educational providers. He is a published author and editor with strong ICT skills brought to bear in the generation of a wide range of educational material. In previous roles he has managed implementation of local authority key skills initiatives; acted as environmental education and humanities adviser; led Ofsted inspection of secondary schools; authored ten multi-media CDs; written six school text books and was formerly editor of Wideworld Magazine for Phillip Allan Updates.

Bernard has specialist knowledge in education, especially of: learning and teaching; curriculum development, learning space design and the application of EdTech.

https://bjdeducation.uk

Dr Elizabeth HidsonSenior Lecturer, Faculty of Education and Society, University of Sunderland

Elizabeth started her career in education as an IT teacher, progressing to ICT Advanced Skills Teacher, Lead Practitioner in ICT and later to assistant and deputy headteacher senior leadership roles. She was the chair of the Westminster Borough ICT sub-group for wave 3 of the Building Schools of the Future programme, responsible for the vision, procurement and implementation of a coherent ICT strategy across the borough's eight secondary schools and a special school. Moving into academia, Elizabeth has been an educational technology researcher on funded projects across eleven countries as well as teaching on PGCE, MA and doctoral courses at Durham University, Newcastle University and the University of Sunderland. She is a committee member of the Technology, Pedagogy and Education Association. Elizabeth is currently the programme leader for the University of Sunderland UK-based blended learning PGCert Education and the assistant programme leader for the PGCE (IDL) course, delivered via distance learning to over 500 students around the world each year https://www.sunderland.ac.uk/about/staff/teacher-training-and-education/elizabethhidson/

Marilyn Leask

Marilyn Leask is Professor of Education at De Montfort University having previously been Professor of Educational Knowledge Management at the University of Bedfordshire and a Professor at Brunel University. She is a trustee of the Education Futures Collaboration Charity[2] and the Bedford and Milton Keynes Waterway Trust. Leask specialises in the knowledge required for teaching, knowledge management in education and in building the evidence and knowledge base for teacher education. Classroom practice has developed from her research on digital technologies and teacher knowledge and how digital technologies can be harnessed to support lifelong learning for teachers. Leask co-chairs the Mapping Educational Specialist knowHow Knowledge mobilisation and Translational research initiative in education.She is a specialist in: teacher education, whole system change, improvement and development across large systems, particularly through online networking and knowledge sharing. marilyn.leask@icloud.com

Rose Luckin

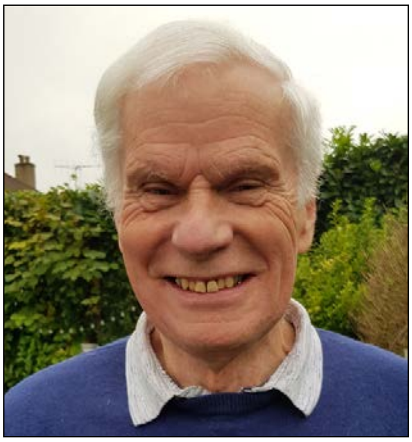
Rosemary Luckin is a UCLProfessor whose research involves blending theories from the learning sciences with techniques from Artificial Intelligence. She is author of 'Machine Learning and Human Intelligence: the future of education in the 21st century'(2018); Director of EDUCATE: a London hub for Educational Technology StartUps, Specialist Adviser to the UK House of Commons Education Select Committee; Co-founder of the Institute for Ethical AI in Education; a member of the UK Office for Students Horizon Scanning panel, adviser to the Topol review into the NHS workforce; one of the 20 most influential people in Education (Seldon List 2017) r.luckin@ucl.ac.uk

Bozena Manova

Bozena Mannova has been teaching since 1989 at the Department of Computer Science, Czech Technical University in Prague courses Programming, Data Structures and Software Engineering. She received a degree from the Czech Technical University in Prague, M.Math. from the University of Waterloo, Canada and PhD from Comenius University Bratislava. Before 1989 she worked as a programmer at the Faculty of Mathematics, University of Waterloo (Canada) and after as a programmer at the Computer Centre, Czech Technical University in Prague. Mrs. Mannova is chairman of the Anglo-Czech co-operation of teachers as International Director of MirandaNet. She was awarded in 1998 European Woman of Achievement Award for the development of the Anglo-Czech learning community for teachers on-line.

Mrs. Mannova is member of ACM and UPE Honor Society. She is member of ACM Europe Board – Council of European Chapter Leaders (CECL). She was cofounder of Czech ACM Chapter and she served few times as President of this Chapter. She has worked for many years for ACM International Collegiate Programming Contest (ICPC) in different roles, now she is Director of European Contests. In 2012 she received The Mark Measures Distinguished Service Award from ACM for outstanding service to the ACM ICPC from 1994. She is author of a few textbooks and many papers. She was author and moderator of information technology educational programs for Czech TV. She has participated at many international projects.

mannova@fel.cvut.cz



Ian Rae

Ian set out on the road to teaching, by graduating in Classics and Music at Glasgow University, and promptly being enticed into the exciting new world of Technology. After 30 years in computers he furthered his teaching credentials, by taking early retirement in 1998, from the role of Technical Strategy Manager at Commercial Union, to concentrate on his music. Since then he has been a peripatetic music teacher, teaching keyboards and composition, written and staged musicals, had his music used in theatre, radio, television and adverts around the world, and had over 100 songs and arrangements published online. Now he is producing silly songs for nursery school children, KS1 and KS2 songs for primary children, and arguing that he's finally in teaching! https://www.ianrae.co.uk/

Dr. Christina Preston - Editor

Dr Christina Preston, the editor of Advancing Education, has been at the forefront of education and technology for over 30 years.The MirandaNet Fellowship that she founded in 1992 has become a global thought leader in edtech with over 1,400 members in 80 countries and an outreach of more than 80,000 website visitors a year who read up to 10 screens. At the core of the members' philosophy is the sharing of knowledge and change management based on grassroots evidence. The members research into the impact of technology and learning in classrooms and report on their findings for the global community. They also run practice-based research professional development programmes in schools when the practitioners become co-researchers. Christina has won 5 international awards for her contribution to education innovation and 'community of practice development'. In this capacity she is on Naace BOM and also helping to found the new learned society, Technology, Pedagogy and Education. She is also an associate Professor of Education at De Montfort University.

christina@mirandanet.ac.uk


bett
22-25 JANUARY 2020
LONDON EXCEL
CREATING
A BETTER FUTURE
BY TRANSFORMING
EDUCATION
MORE INFORMATION
@BETTSHOW.COM