The Move to Student-Centric Learning: Progress and Pitfalls

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Abstract
At ICEL 2014 in Valparaiso the authors presented a paper on the importance of developing metacognition in students, to support changes and developments in pedagogy and learning models. Following on from that paper, we now consider and present outcomes from three projects reflecting different stages of the learning continuum, with which we are engaged.

Firstly, the Computing at Schools project in the UK has been running for over five years, and has been successful in gaining the support of the UK government for the introduction of Computer Science teaching in schools at both primary and secondary levels. Critical to the success of this project is a change in the pedagogic model adopted by the schools, moving from fairly standard instructivist models for teaching in the primary schools and in teaching coding and factual information to more constructivist approaches, using flip classrooms and other TEL (technology enhanced learning) tools and techniques to help pupils develop Computational Thinking skills.

Within our own University, we have been working on a project called Greenwich Connect, which aims to provide our students with a comprehensive set of online services and facilities supporting all aspects of the student experience. As part of this project staff are encouraged to develop learning materials using TEL tools, and to adopt more constructivist and student-centric teaching approaches. Within the UK University context, we already have an excellent example of a strong constructivist, student centric teaching model in the PhD studentship. A PhD student is encouraged to investigate the body of knowledge, with appropriate advice and guidance from experienced and knowledgeable supervisors, and then to take control of their own learning process by identifying their research question, experimental model and analytical methodology. They then carry out and write up their research, with their supervisors now available as experts to be consulted at need, and produce an outcome, which, at the point of viva, proves them to be the current world expert in their field. The issues are in applying this model to large numbers of students at an earlier stage in their learning and the resourcing of the facilities required to support this.

One potential approach to deal with the issues of resourcing a student-centric approach to online learning is being investigated in the dCCD-FLITE project, an EU funded project with 7 partners from 6 European countries. The project is developing learning materials on the subject of Entrepreneurship in the IT Industry, and aims to deliver these materials to students in online courses that offer a constructivist, student-centric learning approach, with limited tutor resources and engagement. To achieve this, it allows students to self-select groups to work in, and then introduces two key learning frameworks to be used by the groups to organise and develop their learning - Concurrent Design Method, designed by NASA, and the Osterwalder Canvas.

Keywords: Student-centric learning; computing at schools; MOOCs; Concurrent Design; Osterwalder Canvas.

1. Introduction

As identified in the authors' paper on metacognition at ICEL 2014 (Bacon & MacKinnon, 2014), there is a rapidly growing need worldwide for higher education resources, which cannot be met by existing provision or by the creation of new provision based on existing models. Additionally, there are significant, and growing, mismatches between the skill-sets of those currently in the workforce, over 70% of whom have already completed their tertiary education, and the skill-sets required to meet the needs of modern industries. In order to address these issues, a number of new models have been proposed, discussed and launched, the majority of which are based around online provision of learning materials and greater requirements for student-led or student-centric learning models. However, as discussed in our previous paper, such approaches require a greater level of metacognitive skills and learning maturity on the part of the students, and existing educational models do not explicitly prepare students in this way, predominantly expecting metacognition to emerge as a result of going through the process of tertiary education. Clearly, this does nothing to help those who do not undertake tertiary education, but the evidence is also that many of those completing tertiary education still have poorly developed metacognitive skills and are immature as learners. Therefore, new models must seek to address these issues if they are to successfully meet the future needs of students and industry at all levels, and enable the necessary expansion of higher education and lifelong learning provision.

This paper describes approaches to develop new learning resources for learners in three key sectors, schools, Universities and in adult online learning. All three projects described are investigating how to provide a more constructivist, student-centric approach, which supports the development of metacognition, within a technology enhanced learning environment. The paper describes both the progress achieved and the pitfalls in the approaches adopted.

2. Project 1: Computing At School

The Computing at Schools project in the UK has been running for over five years. Its origins stem from a variety of issues that arose throughout the computing education system in the UK over the last 10-15 years. The computing taught in Schools tended to focus on digital literacy i.e. how to use a computer but not how it worked or how to develop computer applications. In common with many other countries, this level of knowledge was considered inappropriate in the early days of computing, often being analogised to the need only to learn to drive a car, as opposed to becoming a mechanic and understand what is under the bonnet. However, over a period of time it became clear that this strategy was no longer working for several reasons:

- The increasing prevalence of technology in society and the lack of a basic understanding of how it worked meant that people could not make the best use of IT in their personal life or at work.
- There was a shortage of IT professionals in the UK and EU industry which was set to get worse (European Commission 2014)
- A continuing decline in applications to study computer science at University (CPHC 2008).
- Numerous complaints from school pupils about the boring and uninspiring ICT curriculum.

As a result of the above issues, the professional body, BCS, The Chartered Institute for IT (BCS), Academy of Computing and its member association, Computing At School (CAS), the Council of Professors and Heads of Computing (CPHC), and industry represented by e-Skills UK (e-skills UK), jointly campaigned for change. This initiative was supported by the Royal Society which published a report “Computing in Schools: Shutdown or restart?” (Royal Society, 2012). The end result was a change to the English national curriculum in schools with the new programme of study for computing introducing “computer science as a foundational subject discipline that, like maths, music, or natural science, every child should have the opportunity to learn, from primary school onwards, alongside IT and digital literacy.” (Peyton Jones, 2014). As a result, from Sept 2014, it became compulsory in the UK to teach computer science from the age of 5.

Having made this decision, a massive Government funded programme of retraining teachers began across the country, led by BCS and CAS. The approach taken was to train 400 master teachers, with the support of local universities, across England who in turn could train other master teachers who could train the teachers. A major challenge was not only to train the teachers in the subject, but also to train them to use an appropriate pedagogy in the classroom. Primary school teaching tends to be predominantly instructivist in nature, in that the learning is very teacher directed with a carefully planned curriculum. This is for obvious reasons, as pupils of that age have not yet learned to become metacognitive so they don’t know what learning strategies work best for them or how to be independent learners. The focus of the computer science curriculum is about learning to program. The reason for this is, as described by Simon Peyton-Jones (2014):

- It is hugely creative. When you write a program you are making a computer do something it has never done before. The only limits are the limits of your imagination and ability.

- It can be extremely engaging and enjoyable; it encourages playful experimentation, and perseverance in the face of repeated failure.
- It rewards precision of thought. If the program is wrong, it won't work.
- It encourages the ability to reason. If you see "(Forward 3; Turn right) four times" you may imagine the turtle drawing a square. You are reasoning in your head about the behaviour of a program when it is executed. This is a pretty abstract thing to do, but you have a very concrete reason to want to do it
- It is an extremely marketable skill. Nowadays it is not just professional software developers who write programs. Scientists, engineers, data analysts, and many other professions in the knowledge economy, all increasingly involve some level of programming.

In order to teach people to program, the vast majority would agree that computational thinking should be taught first. The term "computational thinking" (CT) was first coined by Seymour Papert (1996), however it was brought to the forefront of computer science by Jeanette Wing (2006). CT is essentially a framework for thinking about the best way to solve a problem and requires the ability to think about a problem in a structured and logical way, decomposing it into individually solvable parts in order to design a solution. It requires a range of mental tools and models, the ability to think precisely and at multiple levels of abstraction, coupled with an understanding of the constraints of the solution space. We use this skill in everyday life, however in the case of programming this requires an understanding of how a computer works and the limits of computation, in addition to the ability to be very precise. It is also a skill that needs to be developed and practiced, it is not one that can be rote learned. Many agree that a student-centred, constructivist approach is important in order to build a strong foundation for future development which will lead to a deep understanding and strong mental models on which to build future knowledge (Computing Explorations, 2012). Not everyone finds computational thinking to the level of precision required easy and so it has been a significant challenge for some ICT teachers and primary school teachers, who have never encountered the subject before and never been trained to do this, to convert. As a skill to be developed, people have to go at their own pace and build on knowledge they have understood, there are no short cuts so this type of learning as pupils have to develop their knowledge and skills at their own pace.

Once the national curriculum changed, many teachers understandably looked for help and advice. As a result, teachers feeling the need for mutual support and to share materials etc., the CAS membership rocketed and stands at about 17K at the time of writing [Jan 2015]. It has also led to a whole host of new resources for schools from commercial providers, the setup of many clubs and initiatives to get the country learning to code and not just school pupils, parents as well e.g. techmums (2015). However scaling up the support has not been easy, and many challenges remain, for example:

- Learning to program is only the first challenge, it takes another level of confidence to be able to debug the programs of others who may approach solving a problem in a very different way. A survey by CAS reported that whilst almost "three quarters (73%) of teachers responsible for teaching computing feel confident delivering the new computing curriculum, many still lack confidence in certain areas, particularly when it comes to creating and debugging computer programmes and computer coding." (CAS, 2015).
- Their survey also revealed, "that two thirds (68%) of primary and secondary teachers are concerned that their pupils have a better understanding of computing than they do." (CAS, 2015), and pupils agreed "with nearly half (47%) of young people aged 9-16 years claiming that their teachers needed more training and 41% admitting to regularly helping their teachers use technology." (CAS, 2015)
- "After the first term of the new computing curriculum 69% of teachers surveyed said they enjoyed teaching computing. However, 81% called for more training, development and learning materials."
- The good news is that teachers have been very willing to share their excellent resources however, managing and classifying these has been a challenge with people taking different views on how the same resource should be classified (CAS Newsletter, Spring 2015).

In order to support and recognise teacher development, BCS and CAS launched a Certificate in Computer Science Teaching in Oct 2014, which has been welcomed by teachers (BCS, 2014). This has three requirements: to attend and reflect on their continuing professional development (CPD), a programming project, and a teaching observation.

The pedagogy of teaching computational thinking and programming is still under development and debate. England is of course not alone in taking this approach, some countries are ahead and some behind, however none have tackled it in quite the same way. England is essentially in the middle of a massive national experiment and whilst there is much to learn from the experience, its achievements to-date have been recognised through an award from Informatics Europe, the association of computer science departments and research laboratories in Europe (Informatics Europe, 2015), which gave their "Best Practice in Education Award" to CAS in 2014.

The introduction of new material into the national curriculum has not been welcomed by all, as inevitably some material has had to move out in order to make space. In order to try and address this, one of the future pedagogical challenges under discussion is the integration of computational thinking into the learning of other subjects with a view to enhancing the learning experience of both. However, perhaps the biggest change brought about by the introduction of computer science into the primary and secondary curricula is the move away from instructivist and didactic pedagogy to more constructivist and student-centric approaches. This move was already taking place through the use of greater levels of technology-enhanced learning, and new ideas such as flip classrooms taking a hold in some subject areas, but the massive upheaval brought about by the arrival of computer science has given significant impetus to these changes. The long term impact on teaching practice and the pupil experience in primary and secondary education remains to be seen, but the effects of a greater level of student-centricity in early stages of education must have an impact both on the practical skill levels of the pupils, and their metacognitive skills, as they find out what works for them in thinking through their learning process and developing their CT and programming skills. As we have already said, there is a long way to go and many challenges still remain, but the trajectory is positive.

At the time of writing (May 2015), we have evidence of the impact of the introduction of Computer Science GCSE in schools resulting in a fourfold increase in the number of pupils successfully studying the subject (ComputerWeekly, 2014), but we will not see the impact of this being a compulsory subject for school pupils until the results in August 2015. However, we would expect at least an order of magnitude increase, given the increase in numbers being taught the subject earlier in the curriculum.

3. Project 2: Greenwich Connect

The University of Greenwich in London embarked on a project called Greenwich Connect (2014), which formally started in 2014 and runs initially through to 2016. The Greenwich Connect project is the University's vision to help make a step change in learning innovation, and it is part of the University's strategic plan so is supported at the highest level, an important factor for success. The focus of the Greenwich Connect project is to transform the learning experience through the use of technology. Its purpose is not only to ensure we produce digitally literate learners but also to change our pedagogy to be more student-centred. In order to deliver on this it is important that both teachers and learners to make effective use of social media to form lifelong networks between learners, faculty, peers, and industry etc. and also that lecturers help students to become metacognitive, in order to prepare them for a life of learning after they graduate.

Traditionally, for most teaching in higher education, we have a stark contrast between the constructivist nature of teaching for PhDs, and the predominantly instructivist tutor-focused approach to the rest of teaching in Higher Education, based around the concept of the lecture. The education of a PhD student in the UK, by its very nature, follows constructivist pedagogy. Formal lectures and classes are dispensed with and the learning, guided by supervisors, goes at the pace of the student who reads the body of knowledge in their field, constructs a hypothesis to be investigated and eventually takes control of their own learning, so that they become the leading expert in their precise area of research. This is of course a very resource intensive approach to teaching and does not easily scale to mass education. Technology has promised to revolutionise education for the last century, however, whilst it has had a huge impact on our everyday lives, within the learning environment the impact on the pedagogy has been minimal to-date. We have however now reached the point where we have the potential to use technology to transform higher education to a more student-centric pedagogy and finally break the mould.

The aims of the Greenwich Connect Project (2014) are to support the development and practices of:

- Social interaction and social construction of knowledge
- Student employability and graduate attributes
- Digital literacy
- Interactive, connected and relevant curriculum
- Collaborative learning, teaching and assessment
- Lasting connections and networks that go beyond the period of enrolment
- Inter and trans-disciplinary research and content
- Innovation and creativity
- A sense of autonomy, personalisation and an enterprise attitude

However having the potential to change our approach to teaching doesn't necessarily mean it will happen. Within the Greenwich Connect project there has been some excellent progress to-date, for example:

- Several committees and groups have been set up to take oversight of the project, ensure engagement from faculty in debates around our virtual learning environment (VLE), use of social media, open educational resources, distance learning and mobile etc.
- GC has begun the development of over 20 projects in the past 6 months, for example a virtual law clinic in which volunteer law students, academics, and legal professionals working pro bono, use an online educational space to provide legal advice to the public for free as part of their educational learning experience.
- The development of novel learning spaces in a few rooms, which provide staff with interesting shaped tables on wheels so that they can be arranged into novel shapes, allowing staff to experiment with different pedagogical approaches.

There are however a considerable number of challenges, for example:

- In order to develop new projects, the technological infrastructure needs to be correct. Even when funding is available, technology is changing all the time and committing to a decision to use a particular technology can be difficult when you know you will have to live with that decision for several years but expect some better to come along soon, you just aren't sure how you would need to wait. A lot of infrastructure work has to be done behind the scenes, which staff and management don't see and can give the impression of inactivity.
- Wanting to support the plethora of technology that staff wish to use, within a fixed resource.
- Staff generally fall into three categories in their view of technology enhanced learning:
    1. The enthusiasts who have always embraced new technology, can't resist a new gadget and are always willing to experiment. All institutions need these people to drive innovation and help to lead the way. At Greenwich this group constitutes about 10-20% of the staff.
    2. The luddites who will resist until forced by management edict to change. This group constitutes about 10% - 20% of the staff.
    3. The rest – the middle ground who, with appropriate support and encouragement will understand the benefits and will change their pedagogy over a period of time.
- The institution challenge is to move group three forward i.e. to achieve a mass change to student-centred learning.
- Another challenge in encouraging staff to change their pedagogy are bound up in a form of performance monitoring. All universities in the UK are externally assessed and measured. As a result most universities have expectations about the performance of their students. This can hinder staff experimentation for fear of reprimand if student performance deteriorates. In order to move forward, staff have to be allowed the occasional fail.
- Another challenge in moving forward is that it takes time to change pedagogy. Whilst it might ultimately lead to less work and happier students, upfront effort to learn what to do, prepare different learning materials etc. means that already very busy staff have to invest time and effort to change and generally less effort is required to keep doing what you know.

- As time passes, student pressure for change and having examples from their colleagues will probably force reluctant staff to change too.
- Digitally literate staff are an important pre-requisite to progress, however staff development is not a trivial undertaking. Online educational resources with short "how to" guides (written and video instruction), available at the time they are needed by staff, can sometimes be better and impact more staff, than attending a course which is forgotten by the vast majority of staff before they find time to use the knowledge learned.
- In the UK a crude measure of the "Proportion of time spent in various learning and teaching activities" (Unistats) is provided to applicants on the Unistats Government website. Some staff are concerned that a change in pedagogy could create the wrong impression to potential applicants.
- One of the hindrances to progress are those of institutional structures which are hard to move, for example the scheduling of contact with student around the concept of lectures, tutorials and labs in an inflexible way, primarily due to resourcing constraints and the need to manage an already complex timetabling and rooming process. Institutional norms can be hard to crack.

The project is in it's early stages, so detailed evaluation has not yet been carried out, and as a result we have limited empirical evidence to date. However, we can state that there are 1800 Greenwich University students currently directly involved in Greenwich Connect projects with academic staff, and therefore directly affected. This represents around 7% of the on-campus population, but with 87% of the University departments currently involved in TEL initiatives under Greenwich Connect, potentially over 20,000 students could be impacted by the project.

4. Project 3: dCCD-FLITE project

The dCCD-FLITE initiative (FLITE, 2015) is a project funded under the European Commission Lifelong Learning Programme and runs from Nov 2013 to Nov 2015. 7 Partners from 6 European Countries are involved. It aims to address several of the EU's priorities, such as: better entrepreneurial skills, closer links between HE and industry, increased knowledge transfer between HE and industry and innovative pedagogies. In the case of the latter it plans to do this through transnational and trans-sector learner groups, coupled with a focus on student-centred learning.

One of the challenges faced by today's graduates when entering the workplace is that they need more than just their degree to stand out from the crowd. There are many employers looking for students with a greater capacity for entrepreneurial thinking, and in this age of globalisation, the ability to communicate and cooperate across cultural boundaries at a distance is growing in importance. Across more of the world there is also a push by most governments to enhance links between higher education and industry, so students able to deliver and work in these areas should have a competitive advantage in the workplace.

dCCD-FFLITE has developed an online course, which is designed to facilitate group work between higher education (HE) students and industry professionals working within the IT sector. To achieve this, it allows students to self-select groups to work in, and then introduces two key learning frameworks to be used by the groups to organise and develop their learning - Concurrent Design Method (CCD), developed and used as part of the Concurrent Engineering process (CE) by NASA at the NASA/JPL Product Design Centre, and by the European Space Agency (Bandecchi et al, 2000), and the Osterwalder business model canvas (Strategyzer 2014) which can be used for both business and personal development. Participation in the course will give employees a reason to find out about innovative practices in their organisation, relevant research, and should encourage intrapreneurial activity. The aim is also to raise entrepreneurial awareness and promote bilateral knowledge transfer through collaboration between the two groups of learners.

CCD is a highly structured process method designed to exploit different stakeholders' often conflicting requirements in an optimal way, thereby increasing collaboration and involvement in groups. Having been adapted for use by distributed teams by project partners, it is also being trialled within the online course by the students to facilitate them managing the interests of different stakeholders at both universities and companies in preparing a business plan.

The online course is scheduled to run twice within the project. Firstly with a small group of students as a pilot, and secondly as a MOOC (Massive Online Open Course). The course is scheduled to be around 50 hours of student effort in total, over a period of 8 weeks, front-loaded with learning materials in the first half of the course and student activities in the second half. As indicated earlier students will self select into mixed groups, and they will develop a business idea through to business plan level, through an iterative process of design, peer review, revision and finalisation, using CCD and Osterwalder Canvas. The final submission of the business plan will be supported by a video pitch, and again these will be peer reviewed.

At this point, the project has run the small pilot, and it has provided a number of key lessons to influence the design of the MOOC. The planned intention of the project was to trial the learning materials and the planned processes, and to determine what extra support would be needed to support the students, allowing for the intention that this course is intended to be student-centric. From the work previously reported at ICEL 2014 (Bacon & MacKinnon, 2014), the authors could predict that a significant proportion of the students would lack the metacognitive skills to manage their own learning, even in a group-based model, and would seek extra direct support, without which they would be unlikely to complete the course. This has been borne out in practice, with students seeking considerably more guidance and support than was available to them, even though the model was clearly explained at the start of the course. The majority of students were not proactive in forming groups, waiting to be told or guided by a tutor, and their commitment to the group was resultantly low. Although the team provided introductory guidance for each subject, and a timeline for activities at both individual and group level, the feedback from students was that frequently they "did not know what to do" and as a result did nothing, awaiting input from tutors. The project had opted for a small pilot initially so that it would be possible to investigate these breakdowns and find out from students what problems they were experiencing, but by the end of the pilot the remaining students were seeking such interaction, making the course a more traditional tutor-led experience. Obviously, this cannot be repeated in a MOOC, since we would anticipate many hundreds of students, which would overwhelm a tutor-led model, so the key lessons are:

- Provide far more information on activities, in a very low level instructivist model, allowing students to choose whether or not to use them.
- Give an equally detailed, step-by-step timeline of activities
- Provide introductory videos for each subject and section of material, on a motivational basis
- Capture student issues and concerns from discussion forums, create FAQs that are updated daily and regularly provide motivational video messages highlighting key issues

In other words, provide detailed tutor input on the learning process rather than the subject content, keying directly into enhancing student metacognitive skills. These key lessons are consistent with our previous research, and may point the way to a design model for these large-scale courses that can provide a constructivist approach to student learning. At the time of writing (May 2015) the MOOC has just commenced with just under 1500 students, so we will have some initial results to report at conference.

5. Conclusions

Perhaps the key conclusion that we should draw from the discussion of these three initiatives is that there is a considerable momentum, across all levels of education, to move to constructivist, student-centric approaches and therefore progress is being made on all fronts. However, the pitfalls that we have described throughout this paper are real, and must be addressed if these initiatives are to be successful. Our existing educational structures, at all three levels of the formal tertiary system, are long embedded in academic practice, learning structures and institutional administration, and are focused on processing the greatest number of students in the most cost-efficient way. The move to constructivism and student-centricity may have significant academic merit, and may prove to offer the best hope for the future of education in the twenty-first century, but it is costly to implement and challenges the status quo. The fact that the UK government has revised the national curriculum, and individual universities like Greenwich are building online student-centric environments for the development of their teaching practice, are very positive initiatives. However, it may be that the biggest driver is and will continue to be the agenda addressed by the dCCD-FLITE project, in providing online learning to support upskilling, reskilling and lifelong learning for the general public, more than 70% of whom have already completed their tertiary education.

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