

**INSPIRE XXII**

**Computing Education  
from  
Enrolment to Employment**

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**Twenty Second International Conference  
on  
Computing Education  
from  
Enrolment to Employment**

**INSPIRE 2017**

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## **PREFACE**

This volume contains the edited proceedings of the twenty second International Conference on Software Process Improvement Research, Education and Training, INSPIRE 2017 held at Southampton Solent University, organised by the Quality Specialist Group of the BCS, The Chartered Institute for IT.

The objective of this conference is to promote international co-operation among those concerned with process improvement by creating a greater understanding of process improvement issues, and by sharing current research through academic and industrial experience. The conference organisers feel that this objective has been achieved. INSPIRE 2017 has attracted papers from international sources, covering a broad spectrum of practical experience and research. The topic areas include making students more employable, MOOCs and learning environments

We would like to thank the many people who have brought this Twenty second international conference into being: the Organising Committee, the International Advisory Committee, particularly for all their hard work in reviewing both the abstracts and the final papers, and the committee members of the BCS's Quality Specialist Group.

The organisers would like to thank Southampton Solent University for their sponsorship.

The Editors



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# **Keynote**



# **Serving Higher Education with Technology – Disrupting Higher Education with Technology**

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## **Abstract**

Technology is increasingly serving higher education by enabling student-centred learning and concerted social learning, extended reach to content anytime and everywhere, insights for educators into progress tracking and learning trends, and cross-institutional academic collaboration. At the same time, technology is providing evidence of negative disruption to the core purpose of education, which is human development and individual preparation for the future. Technology is gradually diminishing the capacity of individuals to critically think and reason, to expand into unfamiliar knowledge domains, and to exploit the learning experience to fulfil the market needs after graduation. In this paper, a review is presented on how technology is disrupting higher education, both positively and negatively. Some recommendations are given with respect to these disruptions.

**Keywords:** Disruptive Technology, Higher Education, Online Collaboration, Social Media Learning Paradigm

## 1.0 Introduction

Just as in many aspects of life, technology today is becoming a trendsetter to the way higher education is designed, evaluated and delivered. Universities around the world are depending more on technology to fulfil its core functions in fostering creativity, and in acquiring, processing and disseminating knowledge [1]. While utilising technology in education is not a new trend we, nonetheless, are witnessing an unprecedented proliferation in the use of newer, smarter technologies that has started to cause a shift in the traditional paradigms of education. This shift is mainly driven by the exponential growth of knowledge, the need for more quality education, and also due to a changing tendency to depend on technology within the new student generation [2]. Adaptive learning systems, machine-learning algorithms, smart mobile apps, online virtual labs, electronic interactive books, and social media are just a few technology examples universities are rapidly seeking to employ to server higher education.

Technology does provide the right set of tools through which a personalised learning experience of individual students can be created. Technology enables knowledge to be shared; that concerning student-learning trends and needs. Technology also provides insights and decision support for educators to enhance the overall educational outcomes.

Anyone can then truly argue the immense benefits of utilising technology in higher education. Indeed, through technology learning outcomes can be targeted more intelligently, issues of teaching can be solved rather informedly, and student-learning experience can be evaluated quite effectively. These benefits are rather overwhelming and cannot be denied. While there might be a consensus agreement on the aforementioned argument to some extent, technology, nevertheless, has introduced some negative disruptions on education that should not be neglected or disregarded when a decision is made to embed a technology within the fabric of education.

In this article, a review is presented on how technology is positively serving higher education through the introduction of welcomed disruptions to traditional educational paradigms. In the interim, a discussion is also made on how same technology is gradually weakening the competencies of many students to be creative, to be able to evaluate and to expand on gained knowledge applied to real life issues after graduation.

The discussion is structured as follows: In Section 2, a review is provided about the significant positive role of technology in facilitating the interactive environment of education for students and educators. Through Section 3, a discussion is give about the negative disruptions of utilising technology in higher education. Section 4 concludes this article and provides some recommendations for educators and decision makers on what to consider when a technology is put into used for educational purposes.

## **2.0 Positive Disruptions of Technology in Education**

Previous studies in the literature extensively discussed the role of technology in positively enhancing education and enabling better learning environments. These positive disruptions are summarised as follows:

### **2.1 Personalised Learning Experience**

Technology enables a true personalised learning experience for individual students. Instead of following one unified learning model with all students, technology helps to adapt a flexible evaluation model for each student. Machine-learning algorithms are now able to collect and analyse individual student data to detect learning difficulties and, accordingly, personalise the learning curve of the educational content to better address these difficulties [3]. For instance, based on the academic achievements in a specific subject the student is given a customised set of questions and practice tests. This set, which specifically matches the aptitude profile of the student, can provide an accurate evaluation on what the student is successfully learning and what learning objectives are needed to be reinforced [4]. Since it is most likely that every student may possess a different trend of learning, educators can rely on technology in creating a non-repetitive pattern of assessment to each individual student that most matches the needs and abilities of the student.

### **2.2 Online Collaboration between Students and amongst Educators**

Collaboration between students becomes truly feasible inside and outside the classroom by using online technologies. Technology enables students to share and track subject requirements, to follow the progress of assignments within their groups, and to track their achievements using portals and digital dashboards. Educators on the other hand can easily create and organise requirements, track changes and submissions, view and discuss comments with students, and communicate results with students and management. By utilising technology, productivity can also be increased through collaboration between educators from different academic departments. Online resources, such as reports, templates, libraries, lessons learned and best practises can be shared, and general success trends can also be transferred and adopted [5].

### **2.3 The Social Media Learning Paradigm**

Education is gradually shifting towards encompassing the concepts of social learning driven by the fact that more students are going into higher education with preferences about learning they have acquired throughout their daily use of social media [6]. Most of the students today are digital natives, who are quite proficient with technology. In response to this natural tendency of students to learn via technology an increasing number of educators are starting to post teaching videos and lectures into online channels, such as Coursera, Udacity, Khan Academy, TED-Ed, or even Facebook and YouTube [7]. Indeed, these channels are becoming a social learning stream for many learners around the world, with no bounds by

classes or that of time constraints [4, 8]. In this sense, education is taking the form of a socially shared paradigm in which educators can even exploit social media to assign different learning challenges to students, to enrich discussions amongst students themselves, and to support student self-regulated learning approach within different educational contexts [9, 10].

## **2.4 Better Insights into Academic Progress**

Technology makes it easier for educators to design customised tests, deliver them through different devices like PCs, tablets or mobile phones, scan test scores with a mobile phone's camera, and export scores to a third party application, e.g., Microsoft Excel, if needed [11]. Solutions, such as BubbleScore, Knewton or Google Classroom provide powerful analytical tools to help educators to analyse and evaluate the dataset of each student, detect patterns of difficulties and to map results to predefined thresholds. It is true that students do not have comparable types of intelligence. Therefore, learning objectives cannot be achieved based on the "average student" model. As a result, the individual evaluation of each student permits better insights into the learning path of the student in which difficulties of learning can be detected early and a course of customised actions can then be planned and taken to address them [12].

## **3.0 Negative Disruptions of Technology in Education**

Since technology is supposedly offering quality educational opportunities to students, promising better alternatives to tackle traditional learning issues, and also due to the fact that almost all students in this digital age are increasingly relying on whatever technology at their disposal, it is reasonable to say that universities will keep investing heavily in technology for higher education. However, the key to enhance education cannot be achieved just by adding another technology, but rather by understanding how the technology should be controlled and utilised. Although the advancements in technological solutions in education are truly astounding, the researcher believes that total reliance on technology alone hinders the core purpose of education, which is to prepare the educated generation who is capable of thinking critically, evaluating and reasoning real-life issues without the use of any technology.

In a survey on technology-related research that was conducted by Pew Research Center in 2012 [13], the researchers found that technology is altering how students learn. There was a mounting indirect evidence that technology can affect the behaviour of the student because of its continuous stimulation and rapid shifts on attention. The results also found that technology created "an easily distracted generation with short attention spans" where students could not write, communicate face to face, or critically think without the aid of technology [13]. Many students, for example, heavily rely on the AutoCorrect function of Microsoft Word to fix typing mistakes in their reports and assignments. This would only eliminate the necessity for the student to know the correct spelling of words, hence his or her ability to write in a correct style when the technology is absent.

Another issue that was reported in the survey is that students developed an almost total dependency on online search engines and informative websites, such as Wikipedia, in which students became so accustomed to getting quick answers to the point they would stop searching when no easy answer appeared [13]. Indeed, there are concerns related to creativity since finding easy answers with technology nearly negates the need for students to think for themselves, to better learn and remember information, or to originate new ideas from existing ones [14].

Another point of argument is that knowledge acquisition that is transferred from educators to students is partially due to the student's attention to the nonverbal behaviour of the lecturer. Face-to-face human interaction and mutual direct conversations are extremely vital to the delivery of a quality education, and to the development and acquisition of knowledge-based interpersonal skills. As explained by Brockbank and McGill [15], over 50 percent of the message is usually communicated through facial expression or body language, while about 30 percent travels through the tone, volume or pitch of the voice. People tend to pay attention to the speaker's voice or body language to deepen their understanding of the conveyed topic. Technology certainly has the ability to remove the nonverbal communication once used in an educational environment. The second important attribute in nonverbal communication is the educator's awareness of the individual needs of students. Educators are usually attentive to the subtle signs and reactions of students in the class, where educators usually elaborate more on issues when the perception that more explanation is needed. This attentiveness almost disappear when technology is used to communicate the educational material [16].

Finally, technology can also enforce inequality amongst students. Tests and assessments that are customised according to each student's learning curve, using learning-machine algorithms or any other technology, can still favour some students over others. A student who is reasonably aware of how technology works can deliberately intend to produce a mediocre result at one point to adjust the difficulty of later tests and assessments. Another point of view is that students who are quite comfortable with technology can be expected to produce better results from those who are not. This would only introduce a digital divide in an environment where digital solutions are used only to avoid it.

## **4.0 Conclusion**

Disrupting the traditional ways of education by introducing a new technology cannot be guarantee in enabling better educational environment with proven outcomes that focus on preparing individuals with positive impact on society after graduation. It is true that technology is an absolute necessity in higher education nowadays, but what is more important is how technology is put into use and exploited. Technology is just an enabling tool for learning. It should not be perceived more than that. Technology can, and should, help teachers to monitor how students are progressing, and what difficulties in learning student are facing, but no machine-learning algorithm can replace a human in bringing creativity and problem-solving insights and experience to the classroom, physically or virtually.

In addition, relying solely on technology to evaluate the learning experience of a student can be rather risky. As contended by Bernard Bull, technology should not drive the decisions instead of serving as a diverse collection of tools to help achieve the planned goals of education [17].

Another point on the same level of importance is that we have to be very clear in differentiating between information access and education. Students do need to access information using whatever tools under their disposal. Indeed, online databases and search engines can speed the process of looking up, matching and connecting information, but how information is assessed, digested and relayed within the educational context is what really matters. Students have to learn it the hard way; the old traditional way of digging up information and sifting through hard copies of reference books or libraries should accompany the use of any technology. Such manual searching skills can only be mastered by experience, eventually to draw the potential of the student to relate and summarise notes using pen and paper, to compare and contrast ideas, and to expand on additional related references.

In conclusion, technology in higher education is here to stay, but when a decision is made to rely on a technology that technology should be always scrutinised, totally controlled and restricted to its intended role only, taking into account its limitations and defects. To close this discussion the researcher quotes the following statement from a book titled "The End of Education" by Neil Postman [18]: "All technological change is a Faustian bargain. For every advantage a new technology offers, there is always a corresponding disadvantage" [p. 192]. The statement really serves the argument of this research on the need to ever judge technology and always evaluate the consequences of utilising it in higher education.

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**Section 1**  
**Educational Issues**



# **Introducing Industrial Computer Networks into the Curriculum through a Partner Informed Case Study**

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## **Abstract**

Today an increasing number of systems and devices are being interconnected. The popular perception of this Internet of Things is of domestic appliances existing in comfortable or air conditioned environments connected to the Internet. However many systems that need to be interconnected exist in harsh environments such as extremes of temperature or in hostile environmental conditions, for example railway trackside equipment, utility plants or even at the bottom of an ocean. The network devices employed in these systems must operate in such harsh conditions. Westermo Data Communications manufactures networking equipment of this nature, for what we might refer to as the field of Industrial Networking. There is increasing demand for personnel with the experience and expertise in the design, implementation and management of these industrial networking systems. This represents an opportunity for the future employability of students enrolled on the computer networking degree programme at Southampton Solent University. Westermo has partnered with the University to help develop the unique industrial networking skills required by this sector through

means of a case study based on a real world industrial networking scenario. This paper discusses how students developed solutions to the case study based on research supported by practical experience with Westermo equipment and informed by supporting material from their own teaching programme. Students also have the opportunity to gain Westermo certification to provide supporting evidence of expertise in this area.

**Keywords:** internet of things, industrial networking, case study

## **1.0 Introduction**

### **1.1 Industrial Networking and Rationale for Partnership**

Advances in technology and the Internet have allowed a growing number of devices to be interconnected around the World, driving the demand for information gathering and remote management of systems and has given rise to the Internet of Things (IoT) [1]. It offers a means for connecting domestic systems over the Internet as well as the ability to remotely manage and monitor industrial systems, for example power generation plants, railways or marine and offshore installations [2]. Until recently many of these systems were managed on site as autonomous systems, however today there is a rising need for their interconnection and remote management [3]. Therefore there is a demand for engineers with the technical skills to implement and manage the new technologies required to enable these systems to be interconnected. Hence Industrial Networking is becoming an increasingly important dimension of the computer networking subject area. Industrial Networking devices are often expected to operate in harsh environmental conditions from extremes of temperature to extreme humidity [4]. This has required the design and manufacture of specialist networking equipment for this purpose. One company manufacturing and supporting this type of equipment is Westermo Data Communications. Southampton Solent University (SSU) have sought to form a partnership with Westermo to enrich the curriculum of the Computer Networking Degree programme, piloted in an existing unit within the programme. A case study, based on a typical Westermo customer, served to aid the learning strategy in the chosen unit.

### **1.2 Industrial Networking Partner**

Westermo was named after the village where it was born, Västermo, Sweden, in 1975 and was established by a pioneer of Industrial Data Communications, Tore Andersson. In 1995 Alan Bollard, currently the Managing Director, developed Westermo UK. Alan has positively influenced the company and helped develop the organisation's growth within the UK [5]. From where Tore began, Westermo now

employs over 200 people and has 11 other sales and support offices around the world (including the UK) and thousands of industrial based customers. The products are still produced in Sweden to this day and are arguably a global competitor in the field of Industrial Ethernet Switches.

Westermo started to notice that within the industrial network sector a knowledge gap was developing. People were retiring and removing important skill sets from the ever-developing industry, whilst the skillsets required are constantly evolving. In 2014 Westermo embarked on a new challenge. They wanted to introduce a new member of staff to the Technical Support team at the UK Headquarters near Southampton, although they had some difficulty finding a suitable candidate. In August, a graduate fresh from Southampton Solent University applied for a job with the company, although with no relevant industrial networking experience, but a degree in Computer Networking that proved to be the a deciding factor in their employment. Westermo wanted, with the assistance of their recent graduate, to create this new affiliation with the university.

Westermo is actively helping to educate students at SSU by running guest lectures, donating relevant equipment and providing technical advice to students, including email support. Westermo want to find the future employees for their customers and more importantly help to bridge the knowledge gap of the industrial data communications sector.

Working in collaboration with Westermo, SSU has seen development in a sector that is often overlooked in the typical model of teaching in the field of computer networking technology. SSU envision students gaining vital experience from the collaboration with Westermo therefore leading to improved employability and enhanced career prospects.

## **2.0 The Case Study**

### **2.1 Background to the Case Study**

The University has a Computer Networking Degree programme. The topic of the Internet of Things had been introduced into the programme over time to keep up to date with current and future technology trends, however prior to the discussions between the course team and Westermo there was little content relating to Industrial Networking in the programme. There were two possibilities for introducing this emphasis in the curriculum. The course could be re-organised and revalidated to incorporate more industrial networking or the subject area could be introduced into an existing unit. There will be opportunities to look at the whole programme in the future, but revalidation would be time consuming. However a suitable undergraduate final year networking unit proved to be eminently suitable

for incorporation of this theme into the curriculum. The unit outcomes were related to employability which is seen as key to graduate employment. The unit involved student centred learning, which is seen as an effective way to engage students in the learning process by means of active learning [6,7]. Employers are seeking graduates with soft skills, such as team working, communication, presentation, and technical skills such as research and practical experience, so the unit was designed to provide opportunities to develop these [8]. The unit involved students in selecting a case study from a sector of business and industry. They are expected to produce a set of requirements for the case study relating to a particular computer networking theme. From this they are expected to develop solutions that may involve elements of practical work. However the type and nature of the topics chosen by students varied widely and the tutor often found it difficult to find time in the sessions to support the wide range of technical issues presented to them. The standard of outcomes was variable and some students avoided practical work. The unit leader had been intending to concentrate on just two or three topic areas that incorporated practical laboratory work in their solutions. The partnership with Westermo gave the opportunity to introduce a case study based upon a real life-like scenario faced by a typical customer. To offer choice to the students and to ensure that the practical session could be manageable two other themes were introduced: network management and monitoring using OpenNMS [9] and Software Defined Networks [10]. Separate case studies were developed for these themes. Students were given the choice of which theme they wished to pursue. Eight students from two separate sessions chose to engage in the Westermo case study and with two sets of equipment available this number would be easily manageable.

Westermo run their own certification programme for their customers. They have a standard laboratory configuration using their own range of Lynx and Wolverine layer 2 and 3 switches. They were able to donate two complete laboratory configurations to the University. Westermo have developed teaching and learning materials for their certification programme consisting of a study guide relating to the theory and a practical exercise guide relating to the practical configuration of their systems.

## **2.2 Case Study Implementation**

The case study that Westermo offered to the networking students was based upon a fictitious company that managed a number of road tunnels. This offered a situation similar to some of Westermo's typical customers [11]. From the scenario students were expected to develop a more formal set of requirements upon which to base their work. They could act in the role of a consultant negotiating the requirements with the customer in the form of the tutor and a representative from Westermo's technical support team who was closely involved with the project. This person was also able to visit the students to deliver an initial guest lecture on the subject of Industrial Networking and also to field targeted questions from students. The outcomes of the unit involved students in developing a set of solutions for the requirements of the case study supported by theoretical research and practical work on the Westermo equipment. The scenario required a resilient local area network at each tunnel to which could be connected IP enabled CCTV equipment, emergency



phones, legacy ventilation fans, messaging systems, number plate recognition systems and other sensors. Three players were involved: the company responsible for managing the tunnel, the Highways Agency and the Police. The network at each tunnel had to be connected via a secure link to the head office and also parts of the network should be connected to the other players. For example the Police must only have connectivity to certain parts of the tunnel systems, such as number plate recognition and CCTV, whereas the Highway Agency might have access to other systems. Students were expected to deliver a report on the solutions to the requirements and eventually to present the results of their work in a seminar presentation. The findings had to be supported by practical laboratory work using the Westermo networking devices. Whilst students were encouraged to work in small teams to share some resources their final report on the case study would have to be based on their individual analysis of both requirements and solutions.

A strategy with two outcomes was recommended to students. This strategy involved students in reading the study guide to assimilate the theoretical concepts and then working their way through the practical exercises provided by Westermo. One outcome would result in evidence gathering to support solutions to the case study. The other outcome gave students the opportunity to take the examination for Westermo certification.

During the guest lecture delivered by a member of the Westermo technical team the concept of Industrial Networking was introduced and its importance in building connected and managed systems emphasised in relation to current and future networking trends. In order to assist their understanding of the context of Industrial Networking students might consider this as a part of the Internet of Things (IoT).

### **3.0 Outcomes of the Case Study**

#### **3.1 Development of Solutions**

Students were expected to correctly identify the most suitable solutions for the requirements of the scenario. For example a resilient network should be constructed at each tunnel using either a single or dual homed ring network using the Westermo proprietary Fast Re-configuration of Network Topology (FRNT) protocol. The connection between a tunnel and the head office would require a Virtual Private Network (VPN). Resilience of this link would require a dual homed connection, perhaps utilising Virtual Redundant Router Protocol (VRRP). Restricted access and segmentation of various parts of the tunnel network might require Virtual Local Area Networks (VLANs), with each agency and the tunnel company only having access to their own VLAN. A routing protocol, such as Open Shortest Path First (OSPF), might be required to allow correct routing on the local area network and a firewall could be used to improve security at each site [12]. The Westermo certification training mainly comprised these technologies. Students were expected to follow the training and laboratory materials available from Westermo and to take screenshots of practical work to support their discussion of each part of their solution, although it wasn't necessarily expected that students

should implement a working solution to the problem as a whole. This would allow students to follow each part of the Westermo certification program and at the same time to extract information relevant to the case study to provide a complete solution.

Some students who had chosen the OpenNMS case study decided that they would instead utilise the Westermo tunnel case study as part of their investigation. OpenNMS is a network management and monitoring system that uses the Simple Network Management Protocol (SNMP) to receive traps from agents running on a managed network device. So it made sense that the tunnel network should be monitored so that events such as system or network failures can be notified and logged on a Network Management Station. The students using the OpenNMS case study were able to develop their own requirements for monitoring the tunnel networks and they were able to piggy back on the practical work being carried out by those working on the Westermo equipment for the tunnel case study. Since one of the requirements for the original case study involved network resiliency those monitoring the network could develop the requirements of a Service Level Agreement (SLA) [13]. The metrics relevant to the SLA could be monitored using OpenNMS. Students were also able to browse the Management Information Base on the switches with support from Westermo.

### **3.2 Assessment of the Case Study**

Students submitted a report and then presented their solutions in the form of a seminar. In the report they were expected to develop a formal set of requirements based on the case study and analyse the issues. Then they would discuss solutions to the requirements supported by their finding from research and practical work involving laboratory experiments using the Westermo equipment. During the seminar students would summarise their solutions and discuss them with other members of their seminar group. This allowed an exchange of ideas and reinforced their learning.

Since there were additional marks in the assessment of the report for development of the case study and requirements based upon further analysis and research one small group decided to develop their own case study similar to the tunnel network, but based on a typical scenario presented on the Westermo web site. This related to electricity power generation plants rather than tunnels. This scenario also required network resilience. One student investigated solutions for the network, whilst the other investigated monitoring solutions involving OpenNMS and other systems.

Students were also offered the opportunity to discuss employment opportunities in the area of Industrial Networking with Westermo. The best presentation from among the interested students was chosen by Westermo and the student responsible for this was asked to present their solution in front of Westermo management and technical staff.

### 3.3 Feedback Questionnaire

Students who worked on the case study were asked to complete a feedback questionnaire on their work for the Westermo case study. The questions presented were as follows:

- Q1. Did you work with the Westermo equipment?
- Q2. Did you work on providing a network solution for the Westermo case study (or a development of it)?
- Q3. Did you work on providing an OpenNMS monitoring solution for the Westermo case study (or development of it)?

For the following questions please answer the following on a scale of 1 to 4, where:

- 1 = I strongly disagree
- 2 = I disagree
- 3 = I agree
- 4 = I strongly agree

- Q4. The guest lecture that Westermo delivered introduced me to industrial networking for the first time
- Q5. The guest lecture that Westermo delivered enhanced my understanding of industrial networking

If you answered yes to Q1 then please answer the following questions:

- Q6. Working with Westermo has helped me to gain a better appreciation of industrial networking.
- Q7. Following work on this unit I have a better appreciation of the meaning of the Internet of Things.
- Q8. Westermo have supported us well with our work on the case study.
- Q9. I enjoyed the challenge of working on the Westermo equipment.
- Q10. I am equipped to consider Westermo technology for an IoT related project.
- Q11. Gaining Westermo certification would enable me to consider a career in Industrial Networking or IoT

20 students responded to the survey. 13 of those either used the Westermo equipment or monitored a Westermo topology using OpenNMS. However they all attended the Westermo guest lecture on Industrial Networking. Most of the students said that were introduced to the concept of industrial networking for the first time by the Westermo lecture and all but one felt that it had enhanced their understanding of this topic. So whilst this is a positive outcome it indicates that further work should be done on introducing this topic at an earlier stage, bearing in mind that these were final year students.

All but one of those that worked with the Westermo equipment believed that it had given them a better appreciation of Industrial Networking, although only about half of these students felt that this had given them a better appreciation of the meaning of the Internet of Things. This may be because the IoT is a more recent concept and more work should be done on introducing the general concepts at an earlier stage, although Westermo themselves prefer to separate the concept of industrial networking from the IoT generally.

All but one student felt that Westermo had supported them well in their case study and all but one had enjoyed the challenge of working with the Westermo systems. Sometimes business and industry might be reluctant to spare valuable resources engaging with students directly, so it is positive to see that so many students made use of and appreciated the opportunities made available to them for support from Westermo.

Whilst over 60% of students from the group who had worked with the equipment believed that they were equipped to consider Westermo technology for an IoT project, almost 40% disagreed with this. The outcomes of this question may perhaps be ambiguous since one could argue that the students might either be considering their level of interest in a project of this type, or on the other hand their perceived level of technical ability in this area. Although almost 70% of the same group felt that if they gained Westermo certification it would help them to consider a career in Industrial Networking or IoT. Clearly this has made many think of the opportunities available to them, although a few may not want to pursue a career in this field.

The questionnaire was designed to gauge students perceptions of Industrial Networking. Nevertheless it would be interesting to see if the modifications to the unit that have included this subject have improved student perceptions of the unit itself. This information will be available once students have completed the standard university unit questionnaire. Students were also able to provide feedback concerning the Westermo training material and these were passed onto Westermo so that incremental improvements can be made.

### **3.4 Professional Certification**

Students who had worked on the Westermo networking equipment were offered the opportunity to take a Westermo certification examination to enhance their CV. The first group of students took the examination shortly after completion of the case study unit. From the experiences learned from allowing students to study the Westermo course materials for the undergraduate unit it should now be possible to offer the Westermo certification as a stand-alone training programme for other students or for companies that want to train their staff. This perhaps could be run as a short course in a similar way to other professional certification programmes for which the University also has experience of delivering. This will allow opportunities for graduates to work in this sector and enable companies to benefit from a pool of suitably qualified professionals.

## **4.0 Conclusions and Recommendations**

Prior to establishing the partnership with Westermo the University engaged in the teaching of computer networks based on fairly standard concepts. We might consider that most routers and switches were housed in environmentally friendly conditions and designed to address the needs of the average business. For example they might be serving the needs of a datacentre. The relationship with Westermo has enabled us to think out of the air conditioned box. Many industrial switches

exist in harsh environments and as the demands of improved connectivity increase more equipment of this nature will be required. For example railway systems have developed considerably since the days of hand operated semaphore signals. Today both track and locomotive are connected to a computer network [14]. There are many infrastructure and industrial projects where connectivity will be upgraded to meet the demands of interconnection. As there will be an increasing demand for new systems there will be an increasing demand for suitably equipped graduates to meet the challenges of the new technology. The partnership is good for the employability skills of our graduates and it will equip the University to pursue new areas to keep up to date with these challenges. Most of the students feel that this has been a positive and enlightening experience and have appreciated the link with a real business. This work has improved the employability of our graduates by adding Industrial Networking to their skillset which will offer them opportunities in this sector.

Westermo will benefit from developing a pool of suitably experienced graduates. They may either employ them directly or offer the graduate expertise to their clients so that a general upskilling is possible within the Industrial Networking sector. Having trialled the Westermo certification programme on undergraduate students the University could offer this to Westermo clients and also to other students within the University. Westermo clients would benefit from having a suitably equipped training partner to upskill their existing employees.

Industrial Networking was introduced into the programme within an existing unit. However it will be necessary for the course team to investigate ways in which the subject of Industrial Networking can be further embedded within the programme. It could also investigate the viability of incorporating this in an apprenticeship programme in co-operation with Westermo and their clients.

There is no doubt that the IoT generally will be an important part of any computing programme from this moment onwards. This work could also form the basis of a wider awareness of the IoT within the curriculum where Industrial Networking will be an important facet of this subject.

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# **Low Empathising and High Systemising Tendencies in Higher Education Computing Students: the Affordances of Virtual Worlds in Their Education**

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## **Abstract**

*Background.* The increasing societal reliance on emerging technologies is demanding much more from those planning a career in the computing industry than technical ability alone. Many contemporary job roles require business contact, increasing the relevance of soft skills to competent practice. However, the association between those who are inherently drawn to a career in computing and low empathising, high systemising tendencies may present a barrier to future professional success. It is therefore important that the needs of such students are considered as part of their higher education experience, in order to ensure that the development of essential soft skills can be addressed as early as possible.

*Aim.* To evaluate the ability of virtual world (VW) technology, through its characteristics of immersion, identity and interaction, to foster the soft skills recognised as presenting the most difficulty for those with a low empathising, high systemising disposition.

*Method.* A variety of bespoke scenarios were developed for a VW and introduced to an undergraduate Applied Computing programme. These were based on technical activities but with a focus on managing non-routine situations, improving communication, embracing play and imagination as well as developing social relationships. Associations were made between the students' cognitive style and their scholastic performance, including their own perception of the intervention. Consideration was also given to the observations of others, such as higher education unit lecturers, support staff, volunteer VW scenario participants and employers.

*Result.* Achievement for all students was generally found to be better in areas of the course incorporating VW activities. Those with low empathising, high systemising traits considered their communication to have improved the most, followed by their ability to tackle non-routine situations, albeit with some delay in their reaction to the latter. A positive, but less significant, impact was reported for the other skills. However, the contribution of VW activities appeared to be transformational in some students experiencing more severe difficulties in these areas.

*Discussion.* The research provided evidence of the VW as an engaging environment for developing non-technical skills through technical experiences, but raised a number of adoption concerns. While these techniques, applicable to other Science, Technology, Engineering and Mathematics (STEM) areas or indeed any subject discipline that requires an emphasis on sought-after soft skills, could still be implemented by other methods in the real world, the activities may not be as effective as they are in avatar-based VWs.

**Keywords:** Low Empathising High Systemising, Soft Skills, Virtual Worlds, Higher Education, STEM

## 1.0 Introduction

The principle of Occam's razor that 'entities should not be multiplied beyond necessary' has always been fundamental to software development where, for reasons of effectiveness and efficiency, it is always sensible to 'keep things simple'. Unfortunately, the modern environment in which Information and Communication Technology (ICT) products and services operate has turned out to be anything but simple. The computing industry continues to offer an extensive range of career opportunities. However, the exponential evolution of technology and the requirement for specialists who are able to appreciate, supply and/or effectively support the diverse and often sophisticated needs of an organisation including its workforce, means that the demands on those who are drawn to this competitive profession are becoming ever more challenging. Hence, the importance of closing any perceived gap in soft skills between graduate ability and employer expectations [19]. Previous research indicates that those working in the science and engineering professions are more likely to have low empathising, high systemising tendencies than those in less technical occupations [5]. But little work has since been done into how students might be helped to overcome these tendencies, particularly with respect to their interactions with others. It is therefore important that those working in higher education are aware of these learning requirements in order to ensure that students are equipped with the range of skills necessary to excel in an increasingly complex workplace. The specific soft skills identified for this study, illustrated in Table 1, have been informed by prior research [3]. They relate to a below average ability to empathise and an average or above average, ability to systemise, the intention being to use the latter as a strength through which to raise the profile of the former.

*'Below average empathy is a simple way to explain the social and communication difficulties, while average or even above average systemising is a way of explaining the narrow interests, repetitive behavior, and resistance to change/need for sameness. This is because when you systemize, it is easiest to keep everything constant, and only vary one thing at a time. That way, you can see what might be causing what, rendering the world predictable.'*

Table 1: Targeted soft skills for the VW intervention

Trait	Skill
Low Empathising	<ul style="list-style-type: none"> <li>• <b>Communication</b> difficulties</li> <li>• <b>Social</b> difficulties</li> <li>• Problems with <b>play</b> and <b>imagination</b></li> </ul>
High Systemising	<ul style="list-style-type: none"> <li>• Resistance to <b>change</b> / Need for sameness</li> </ul>

The relevance of such skills to proficient practice is promoted by professional bodies, including the British Computer Society (SFI**Aplus**<sup>™</sup>) and the Association for Computing Machinery [1].

*'Successfully applying technical knowledge in practice often requires an ability to tolerate ambiguity and to negotiate and work well with others from different backgrounds and disciplines. These overarching considerations are important for promoting successful professional practice in a variety of career paths.'*

The rationale for this study, therefore, was to assess any impact the educational affordances of VW technology might have on the learning needs of higher education computing students by identifying, describing and analysing the findings with a view to developing associated theory and making recommendations for a more personalised learning environment.

In order to meet the research aim the following objectives were set as research questions (RQs):

RQ1: Does learning in a VW help to diminish the need for routine in low empathising, high systemising computing students?

RQ2: Are VW learning activities able to influence the verbal and non-verbal communication skills of computing students with low empathising, high systemising tendencies and if so, in what way?

RQ3: Is the use of play and imagination in the VW helpful to learning for low empathising, high systemising computing students?

'Imagination' in this context is described as the ability to put oneself in someone else's shoes, to imagine their thoughts or feelings. 'Play' is seen as a spontaneous and active process that allows freedom for the imagination, which in turn promotes innovation and creativity.

RQ4: Are VW learning experiences influential in developing the social skills of low empathising, high systemising computing students and if so, in what way?

## 1.1 Low Empathising, High Systemising Traits Explained

Although the term ‘empathy’, a subject of broad and current interest to neuroscience, is now in common use its origins are relatively recent, the psychologist Edward Bradford Titchener of Cornell University having been widely credited for its first appearance in English in 1909. Translated from the German ‘*einfühlung*’ meaning ‘feeling into’ it was initially understood as being a sort of projection of imagined bodily movements and related feelings into an object or another person, a vehicle that artists might use. However, the exact nature of the feeling continues to be debated. A more modern definition considers both the emotional and cognitive features of empathy as: ‘*an affective response that stems from the apprehension or comprehension of another’s emotional state or condition, and that is similar to what the other person is feeling or would be expected to feel*’ [9]. Others suggest that the affective response does not have to be similar, simply adjusted in a suitable manner by the person feeling it [4], which is the view taken in this research. Systemising is described as the desire to understand, analyse and possibly construct any predictable rule-based system, such as mechanical or numerical systems. It has been theorised that those with an average or superior ability in this area ‘hyper-systemise’ [3].

Low empathising, high systemising characteristics can be described as the representation of a different cognitive style appearing as a continuum across the general population, with autism seen as an extreme manifestation of such traits. This study was therefore guided by an Autism-Spectrum Quotient (AQ), a self reporting test, both brief and simple to administer, designed to assess the degree to which adults with normal intelligence exhibit the traits associated with the autistic spectrum [3]. Although not deemed suitable for a diagnosis, it has been confirmed as an effective tool in a number of studies for the detection of patterns [16]. The average threshold of the test in a control group was measured at 16.4 [5].

## 1.2 Why Virtual Worlds?

A number of approaches have been devised to add value to the development of soft skills in both the real world [22] and the VW, revealing some of the latter’s limitations [14]. However, many of the educational opportunities in VWs are presented by their inherent characteristics, which are both varied and supportive. This study was designed to make use of the ‘3Is’ [7], the unique and inextricably linked features of VWs:

- Immersion - this can simply be described as what the technology delivers from an objective standpoint. Immersion can lead to a feeling of ‘presence’, a more subjective human reaction, and a perceived level of body ‘ownership’ [20].
- Identity - being able to project an individual’s own or a chosen identity via the personification of an avatar can be an extremely engaging learning device. The affective influence of virtual embodiment is strengthened by contemporary research into mirror neurones [18]. These are the specialised brain cells that allow individuals to learn and also to empathise by performing an action or ‘mirroring’ the same action performed by another.
- Interaction - the persistent nature of VWs means that they are always available

for a wide range of interactions such as playing, socialising, collaborating and transacting [7].

Since the central focus of a higher education computing curriculum is seen to be the development of technical competencies, the challenge for the tutor is to find ways of generating in students the confidence they need to be able to effectively apply some of the essential soft skills required in the workplace. This of course can only be achieved by means of the very skills that are inherently difficult for them and here is where the VW offers the most value. The ‘once removed’ [2] activities involving avatars enable students to experiment with roles and acquire valuable tacit knowledge through skills, ideas and experiences in a less self-conscious way than may be achievable within the real world. There is also the benefit of being able to demonstrate the intrinsic importance of particular soft skills for effective professional practice through direct personal experience, which in turn has the potential for increasing the receptiveness of participants to ideas that would improve their own capability in these areas.

The intention of this investigation therefore was to assess the value of this fresh approach that would not necessarily replace, but possibly enhance current methods to foster soft skills. The novelty resides in focusing on areas of perceived difficulty in a way that would be naturally appealing to students who are drawn to technology and expect it to form part of their educational experience.

Although there are many free open-source platforms for VWs such as OpenSim (ulator)<sup>TM</sup> and Open (formerly Project) Wonderland<sup>TM</sup>, Second Life<sup>TM</sup> (SL) was selected for this study as it offered a mature and popular platform for learning as well as research, while continuing to incorporate innovation. In particular, the building and scripting functions available within SL made it a perfect platform for teaching the practicalities of computer science and interactive multimedia.

However, a view that particularly resonates with this research is that of Steils et al. [21] who argue that any technology having the potential to improve student learning should be considered. They discuss ways in which the use of VWs in higher education may facilitate the adoption of a ‘liquid curricula’, simply explained by placing an emphasis on the stances and experiences of both students and staff in order to increase educational versatility. Hence the starting point for the scenarios devised as part of this investigation [6] was to enable vocational students in higher education to benefit from the authentic experiences of others.

## **2.0 Materials and Methods**

The initial strategy was to operate within the broad scope of an Action Research methodology, yet to remain open to other possibilities as the work progressed. Although not usually considered to be a methodology as such, a case study approach was also used to highlight certain aspects of the research. Two students experiencing particular communication difficulties (with the potential for some impact upon their social relationships) formed the focus of this part of the investigation. An initial pilot study was carried out with a BSc (Hons) Applied Computing group, in order to test the chosen evaluation framework which was

based on the de Freitas and Oliver four-dimensional model [8]. This pays due attention to the learner, pedagogy, representation (of the learning experience) and context. A group of FdSc Applied Computing students was selected for the main investigation with the intention of monitoring them throughout the three years of their course. Additional supporting studies were also conducted with two separate FdSc Applied Computing groups, at different stages of their course, to establish whether or not the findings from the main study group were confirmed. The data gathered from all groups were subsequently combined and analysed.

Associations were made between the students' cognitive style (based on their AQ score) and scholastic performance, as well as their own perception of the intervention. The observations of others were also taken into account. A mixture of quantitative and qualitative analysis was carried out for each group of participants on the data captured by the following methods:

Measurement - this consisted of the yearly grades for individuals and groups as well as the accompanying detail of relevant unit grades, assessments and elements within assessments.

Observation - considered to be a key component of the research activities, anything witnessed by the researcher's own senses was recorded, often with some technical assistance, such as video capture software or a digital recorder. In order to gain a broader perspective, observations were collected from other higher education lecturers, support staff, volunteer VW scenario participants and employers.

Interrogation – a significant amount of data was gathered through various methods of interrogation, either individually or as a group, such as surveys (containing both open and closed questions) and discussion forums.

## **2.1 Scenario Design Considerations and Example Activity**

The component elements of VW scenarios were organised in a way that enabled students to obtain experience of the desired soft skills. Wherever possible, activities were designed and constructed with high-systemisers in mind, for example 'rule-based' activities were used to help facilitate social situations, as illustrated in the following 'program-like' guidance:

```
IF two customers arrive at the help desk needing 'urgent' support THEN
    Establish a priority for each problem
    Direct customer with the lower priority problem to 'help guides'
    Deal with the higher priority customer problem
ENDIF
```

The use of realism [13] was also intended to help high systemisers by providing behaviour 'clues', such as the use of a bookcase to suggest ways in which pressure might be reduced on the Help Desk by directing customer(s) to appropriate reference material. Saleeb and Dafoulas [17] indicate that a student's pleasure and satisfaction from an educational space is largely dependent and reliant on its architectural design characteristics, so care was taken to make VW spaces aesthetically appealing. In order to encourage participation, spaces were also

designed to capture the imagination, stimulate creative and critical thinking, independence and experiential collaborative learning. Students were required to contribute to their learning as individuals and/or group members, whether they were participating in scenarios or observers of scenarios, providing feedback. Since learning tends to be deeper when students are more emotionally engaged constructive criticism was actively encouraged and scenarios modified accordingly. The value of this feedback, within the context of an educational experience, helped to increase the intervention's effectiveness as a learning tool.

### 3.0 Example Activity: A Walk in a Green Space



Figure 1: Exercising play and imagination

PrimTime Education - A Walk in a Green Space (Figure 1) was designed to act as a bridge between two programming units by managing the transition from 'structures' to 'classes', the subject being sufficiently troublesome to be considered a possible threshold concept [12]. Since the aim was to reduce the stress often associated with this topic and facilitate learning through play and imagination, the scenario inspiration was drawn from the observations of Roe and Aspinall [15] that taking a walk in a green space, or simply sitting and viewing green spaces from a window, is likely to have a restorative effect and help with attention fatigue. Students entered the scenario in the small 'business groups' they were allocated in the real world and explored the space, learning from their experience. The design made extensive use of real world metaphors to illustrate the underlying concepts. A transfer of behaviour to the real world was also suggested by demonstrating how solutions to end user problems may be better explained to them by means of an imaginative approach and using non-technical language.

## 4.0 Results

Quantitative and qualitative data analysis indicated that achievement was generally better in areas of the course incorporating VW activities (detailed in Table 2,

summarised in Figure 2) and that VW elements enriched both formative and summative assessment (Figure 3) as well as learning activities.

Table 2: Unit grades involving VW vs no VW activities

Group Name (Year)	A(3)	B(2)	B(3)	C(1)	C(2)	D(1)
AQ>16	10	5	2	-3	6	6
AQ≤16	15	6	2	-4	4	0

The analysis of qualitative data indicated that low empathising, high systemising students considered their communication to have improved the most, followed by their ability to deal with non-routine situations, albeit with some delay in this reaction. Overall, a positive, but less significant, impact was seen in the development of play and imagination, as well as improved social interactions.

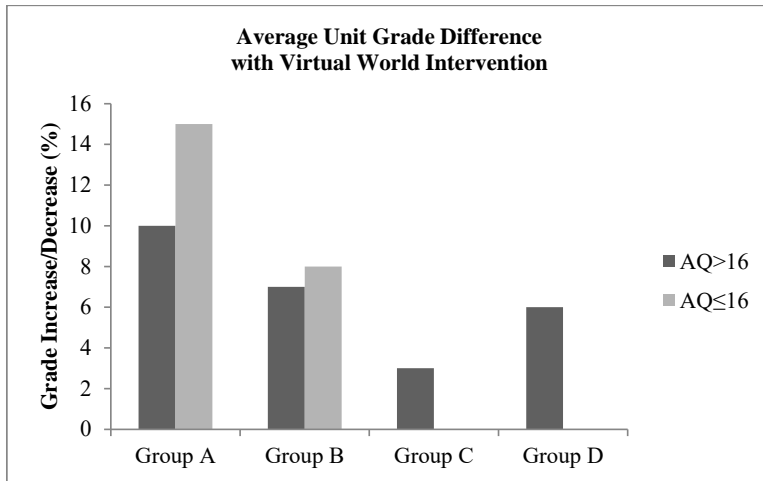


Figure 2: Average Unit Grade Difference

While the notable personal development of the case study students could be attributed to a number of influencing factors, it was clear from their attainment and feedback that the VW experiences had played an important part. The case of Student 2 was the most dramatic, the unit lecturer's initial assessment being: *'This student has very good technical skills however he cannot be a successful web developer simply because he needs to communicate with the client – explain to them the requirements of a web site and explain his product'*. Following the intervention, Student 2 even chose to seek out/interact with external clients for work-based projects a year earlier than the course programme required. The following are examples of his feedback: *'I enjoyed the use of browsing the scene for any clues and having a designated time slot to hold an interview with a real user'*, *'It was beneficial yes! I am keen to continue using a virtual world'*.



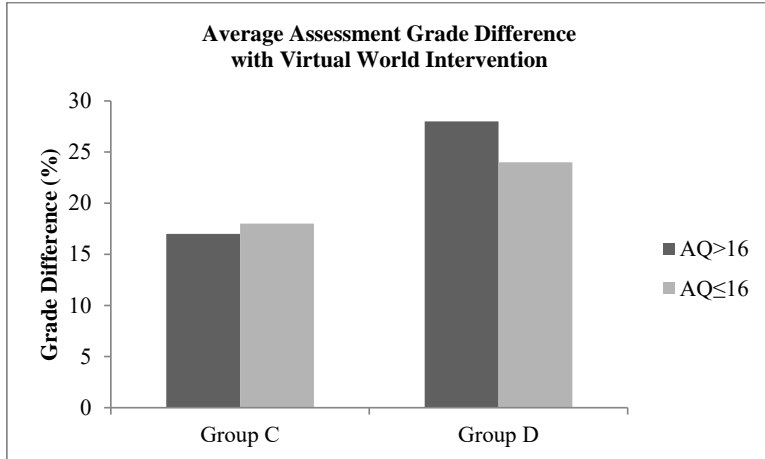


Figure 3: Average Assessment Grade Difference

Two additional themes emerged from the study. Firstly, in situations of more severe difficulty with certain soft skills the contribution of VW activities appeared to be transformative, as seen in the case studies and also in the main study group. Secondly, some dissatisfaction with the VW representation was expressed by students with high AQ scores ( $\geq 32$ ): *'It doesn't help me personally at all [...] so detached from a RW situation. [...] Do they have medicine bottles at the Doctor's? the prescriptions would be in boxes.'* (Group D, Discussion Forum), thereby confirming aspects of previous research, particularly the use of metaphor [10].

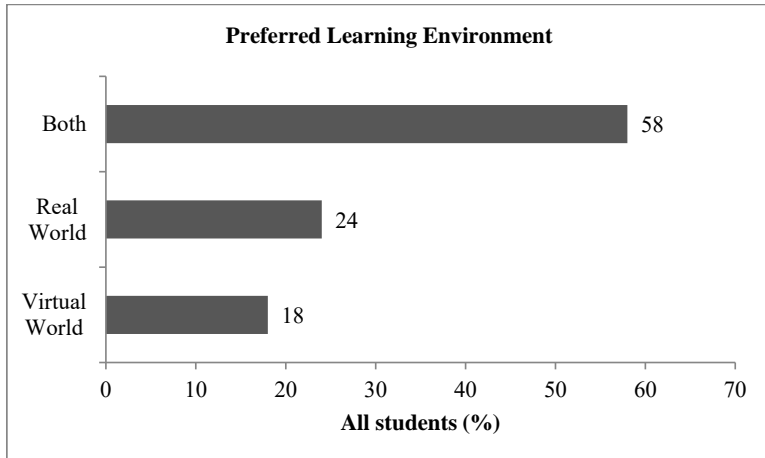


Figure 4: Preferred Learning Environment

Students were asked to consider the advantages and disadvantages of developing the targeted soft skills within the real world and the VW as they were presented during the course of their studies and to state their preferred learning environment: the real world, the VW or both. The results, summarised in Figure 4, showed a tendency to select 'both', with some low empathising, high systemising students selecting the VW only. While comments were not specifically sought in the survey, certain students took the opportunity to clarify their selection and this feedback demonstrated a bias in favour of the VW when 'both' was selected. None of these comments related to the technical issues and regardless of the amount of disruption and accompanying frustration they caused, students only occasionally reported poor technology as a reason for impeding participation. The preferred learning environment generally reflected the positive reaction to the VW in the open survey comments. However, a close examination of the data tellingly showed that all students with an AQ score  $\geq 32$  selected the real world only as their preferred learning environment.

## 5.0 Discussion

The outcome from this research was the creation of a variety of bespoke VW scenarios that provide undergraduate computing students with more opportunities to learn and practice soft skills through technical experiences [6]. There has long been an acknowledgement of the need for soft skills in the computing industry and attempts have been made to hone them by various means [11]. While many studies have been concerned with the needs of employment, less attention appears to have been paid to the problems some students face in acquiring soft skills, particularly those studying STEM subjects.

This investigation contributes to shaping best practice guidelines by creating an understanding of the way in which the needs of these students may be better accommodated in their higher education. The research indicates that a more tailored pedagogical approach was made tangible through the versatility of VWs, specifically SL with its potential for collaboration, immersion, aesthetics, creativity and social interaction. Such affordances not only made it possible for students to confront their anxieties, contributing to improved learning and attainment, but also helped them to engage more profoundly in their studies. Nevertheless, a number of barriers to VW adoption were also uncovered, such as the challenges involved in the creation and implementation of scenarios as well as the need for additional resources. A number of persistent technical issues required some extensive contingency planning, particularly when any form of assessment was involved. In this respect the VW brought as many problems as it did opportunities, hence the need to also find solutions in the real world. It would be possible to implement the 'essence' of these scenarios by other means, such as using classroom-based role-play activities or real world field trips, for example a visit to a park or any 'green space' could be a substitute for the 'PrimTime Education' scenario. However, the outcomes may not be quite as effective as in avatar-based VWs.

There are a number of directions in which this research could be progressed. A longitudinal study on the affective influence of the learning platform could

establish whether the effects were maintained and if there were any generalisations to daily life. It would also be interesting to involve students in the design and development of scenarios to assess any influence this extended participation in their education might have on subsequent achievement. It may be particularly useful for those with AQ scores  $\geq 32$  to suggest ways in which their requirements might be honed and integrated into scenarios that could be used by all.

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# Research Questions and Approaches for Computational Thinking Curricula Design

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## Abstract

Teaching computational thinking (CT) is argued to be necessary but also admitted to be a very challenging task. The reasons for this, are: i) no general agreement on what computational thinking is; ii) no clear idea nor evidential support on how to teach CT in an effective way. Hence, there is a need to develop a common approach and a shared understanding of the scope of computational thinking and of effective means of teaching CT. Thus, the consequent ambition is to utilize the preliminary and further research outcomes on CT for the education of the prospective teachers of secondary, further and higher/adult education curricula. This research study comprises a proposal for carrying out research and development practices regarding the teaching and integration of mathematical and computational thinking in the curricula. The emphasis is put on the following research agenda, aiming at: a) clarifying the meaning of CT and its scope, b) identifying cross-curricula and other approaches for teaching CT, c) providing a generic curriculum design for CT for students and teachers and d) finding possible obstacles, limitations and bottlenecks for the realisation and evaluation of the previous.

**Keywords:** Computational Thinking (CT); Mathematical Thinking (MT); Curriculum Design (CD); Further Education (FE); Higher Education (HE).

## 1.0 Background and Introduction

An interesting question that recently occupies the minds of computer science researchers, teachers and curricula designers is:

*Why computational thinking is on the teaching focus for achieving/advancing digital literacy?*

It is said that there is no better way to answer a question than asking another question. Thus, herein we attempt an answer, by posing many other questions!

*What is computational thinking and how is it contextualized?*

There seems to be an obvious genuine need for a robust and agreed definition and a scope of computational thinking (CT), in order to identify its teaching aims, purposes and learning outcomes better. Since Wing in 2006 [1] popularised the term „computational thinking“, which was coined by Papert in 1980 [2] and 1996 [3], there has been confusion about what exactly computational thinking means; Papert associates clearly CT to generative and generic mathematical thinking and associated mathematical education. Jones in 2011 [4] argues that Wing [1] never really gave a solid definition of what exactly computational thinking is; only a number of characteristics of computational thinking. Perhaps for this reason Wing’s understanding of computational thinking encompasses a very wide range of ideas; everything from „a way that humans, not computers, think“ to „for everyone, everywhere“ (p. 35). Yet, humans think in a very large variety of ways. [4].

*Is there a need to re-define, refine and deepen the concept and scope of CT?*

Some even have asserted that there is no need for a precise definition of CT. For example, Guzdzial in 2011 [5] supported the idea that a very broad definition is enough. However, this runs the risk that the focus will be moved from what CT is to how it should be taught. The obvious importance of digital literacy in our era can be evidenced from the attention it is paid to, ranging from primary school to job careers in the adulthood. People’s every day activities from primary school to adult education and future careers have been fully automated or technology-based that many require from the ordinary user to have some knowledge of computer technology. Thus, programming skills, computational modelling skills and associated thinking skills have become a mandatory part of everyday routine to an extent that school curricula should cater to provide these for future citizens. Computing, analyzing, representing or selecting data nowadays happens with the help of computer-oriented actions. No one can deny the importance of programming and computation in everyday life, and this is the reason and the need to introduce relevant knowledge and make programming and CT a part of the curriculum at schools. Notwithstanding, the challenging questions still remain:

*How to teach programming and CT and who could teach them best?*

Admittedly, using software and hardware, which are vital parts of computer programs, is not so difficult. Pressing some suitable buttons and getting some useful results can be taught during a short time. But how can someone make that machine program do exactly what is precisely wanted to do in a correct way? That is the question, which brings to the deliberate action for becoming a teacher of

programming and *computational modelling* at a more abstract level. For being able to make the mysterious machine to do what you want, you need to find an acceptable and provable way to communicate with it, ideally as you would have to do if you needed to communicate with another human. But there is a problem - this machine cannot understand you (and your natural language) as cannot understand many other people worldwide (and their different languages). For this reason, programming languages have been invented. Each one serves a specific purpose and makes programmers' lives „somehow“ easier, or at least, less complicated.

Learning a programming language for being able to do the basic computing operations is not so difficult, as it is not so difficult to learn any human language for covering the basic functions in everyday life. But learning a spoken language for understanding the meaning between the lines in conversation or in written text, learning to understand the jokes or generally “feeling” the language, is not an easy task. This has many requirements and many conditions that affect the learning process. Generalizing this idea in terms of a suitable programming language, someone can observe that it is not so hard to learn the basic commands of one specific programming language, or it is not even hard to write some simple lines of code; but coding general computable solutions for any given problem is a challenging task and also has many pre-requisites and needs. Two of them, and probably the most important, are to be able to a) think and b) communicate with the mysterious computing “machine”. This, for the record, could only and in a very broad sense, be called computational thinking (CT)!

In mathematics teaching culture the latter sounds like the norm on how CT should be explained to students. For a mathematician though, it is necessary to define the concept from an abstract point of view before analysing it. Apparently, the need for teaching CT is not new; it has only recently been emphasized and popularized [6]. In Finland (and many other EU countries) [6] the new curriculum makes it obligatory to teach some basic ideas of programming and computing independently or during the maths lessons in primary, middle and high school. Further, since the final examinations of the Finnish high school (OY kirjoitukset) are becoming computer-based from 2019, the need for an increased digital literacy is obvious.

## **2.0 Talking About and Beyond Computational Thinking and Computational Modelling**

Apparently there seems to be no „current expert“ to define the apparent need and relation of computational thinking and digital literacy, but tentatively speaking the digital literacy's preliminary role seems to be somewhat parallel with computational thinking. It seems to be like a subset of the skills used by a computational thinker and modeller and at the same time, depending on the definition used, reaching the borders of computational thinking. Earlier research in computational modelling (see e.g. [7, 8, 9, 10, 11, 12, 13, 14]) has touched the need for CT by branching to the use of quite specific thinking skills for designing architectures for services and devices, associating CT and modelling to art, science, education, social interaction, problem-solving, software development tools,

systems design and so on. However, as the use of devices extends the mental capabilities of the problem-solver, accessing the vast interpersonal domain of knowledge to extend the personalised knowledge of the problem-solver, and interacting with the other people to generate solutions, both have an important role in modern day problem-solving processes. The latter of course depends on the problem at hand, and in clear computational thinking there are parallel dimensions.

*Is there a need for educational approaches to develop computational thinking skills for complementing problem solving skills?*

Problem-solving does not begin when a problem is first encountered. The process starts way before that. By and large, the concepts, methods, models, and knowledge (e.g., scientific results) that we use in problem-solving are not generated by an individual, but derived from the surrounding world. Learning is inextricably linked to problem-solving. The process of internalizing the external knowledge, training, and experiences, including e.g. strong (domain-specific) and weak (more domain-general) problem-solving methods into cognitive and metacognitive skills/knowledge, and further refining and connecting the mental schemata is a life-long (learning) process.

It is known that cognitive skill does not transfer well, meaning that something useful from one domain might not (subconsciously) get triggered in another. Also, when a method from the interpersonal domain is internalized into a mental representation of it, it is likely to lose at least some of its potential abstract usefulness. Even when a weak problem-solving method is presented in abstract fashion there still is a context for it to bind to which is the abstract presentation itself. These are important to keep in mind when considering a good way to teach computational thinking to people. Therefore, not only *what to teach in CT*, but also *how to teach CT* are very relevant and valid considerations.

In relation to thinking and problem-solving, CT can be defined around two distinct dimensions. Naturally, it is a set of mental tools and strategies that can be consciously applied in problem-solving situations. However, one might, again, ask:

*Will the mental tools and strategies of computational thinking be applied?*

*Does the possibility of application occurs in the individual learners' conscious minds?*

It is understandable to take the above questions on board since these issues have a lot to do with the subconscious cognitive processes. These tools and strategies exist in the domain of interpersonal knowledge, and they are important parameters in the evaluation of the effectiveness of the teaching of CT.



## 2.1 Intrapersonal Computational Thinking

Computational thinking also exists intrapersonally; it is something that starts forming in an individual's mind in the process of internalization, where the mental representations of the interpersonal domain knowledge are formed.

One of the key questions to address, after the content of computational thinking is defined on the interpersonal level, is:

*Should the approach to teach computational thinking be from abstract to specific or from specific towards abstraction?*

The above question relates to the exemplar and prototype theories. There is much argumentation and controversy on the above discourse, sometimes to pose another (about relevant scope and purpose) question:

*Should CT teaching and learning be tackled from both directions?*

If so, how could one do it without increasing the cognitive load too much? This also relates to the role of use of the *episodic and semantic memory* (that are neurologically distinct systems) in the learning process. Thus, the previous two questions could be re-shaped as follows:

*Is it better to learn by experiencing and abstracting from the experiences, by combining with experiences in different domains, or try to learn more in relation to semantic memory?*

## 2.2 What Distinguishes a Computational Thinker from Other Thinkers?

Working with well-structured concepts and environments is central in computing and computational science; thus the computational thinker is familiar with dealing with these types of problem-environments. These environments are also known as high validity environments. While interacting within high validity environments it is possible for a person to develop something called *expert intuition*, which means that the subconscious processes are able to generate a valuable hypothesis (i.e. good creative ideas) and make them available for the conscious mind. These kinds of explicit processes play a meaningful role in human problem-solving.

## 2.3 Computational Thinking applied in Problem-Solving

When computational thinking is applied in more ill-structured problem-environments, it is important to be aware of it, since in ill-structured environments things work differently. Different kinds of approaches are required and the intuitions can become unreliable. (With ill-structured concepts and environments expert intuition is unlikely to develop, because it requires somewhat clear and immediate feedback of the correctness of the provided result, which in generally is

not available when dealing with ill-structured problems). This is something to be paid attention to, when the cognitive skill transfer is tried to be facilitated by applying computational thinking in different fields. There are also other possible biases that computational thinking can cause when applied in other domains. These should be mapped out in order to figure out a good approach to guide to transfer CT between domains. Compared to other types of sets of mental tools, e.g. De Bono's six thinking hats [15], one can observe that the mental tools provided by CT have a clear emphasis on targeting to guide to interact with interpersonal things (concepts, processes, phenomena, etc.) and not so much with the intrapersonal ones.

### **3.0 On suitable Research Questions and Research Methodologies to advance knowledge on CT**

Following the results of the preliminary literature review of Tiensuu in 2012 [16] and 2013 [17], we have reached the conclusion that there is a need to proceed to the next three metalevel generic and strategic research questions:

*RQ1: What research is needed to further the CT agenda in formal and non-formal education settings?*

- Whatever research aim/activity should be able to show clear cognitive benefits of computational thinking in comparison with other types of thinking; which is research that has not been done. The outcomes should also show that there are meaningful transfers that can happen in reality; which, in turn, would be a good thing, as some of these weak problem-solving methods are criticised for being too general to actually offer any help with anything a little more challenging.

*RQ2: Can/should schools provide all school-children with learning experiences that aim to nurture their CT skills (in all school subjects)?*

- Maybe, but probably mostly within other topics as domain specific problem-solving methods are superior, compared to domain general ones. This would be a safe approach through suitable problem choice and problem-based learning. Even if this new type of thinking does not produce many benefits, at least school-children and (future) work and society still get their strong methods for problem-solving in diverse contexts.

*RQ3: Should mathematics teachers teach computational thinking to the students?*

- This question often comes up due to the shortage of resources (e.g. staff and time). Mathematics teaching is in the curriculum for making the students familiar with mathematical concepts, teach them to solve problems, but also to think in mathematical (also computational) ways, which is a demanding

task. It might even be a good idea not to have an interdisciplinary or multidisciplinary approach at the initial stages of learning how to think mathematically and computationally. For instance, when the target group is middle school students, who do not have yet a solid knowledge of what is mathematics and what is computer science, the teaching and learning methods can vary and can be applied differently for the exposure of similar or different concepts. Further research and development is needed to find out.

Subject specialists could probably embrace creative methods of teaching and learning providing that they want to transfer their specific knowledge and subject passion to others. For this reason mathematicians might be best to teach mathematics at school, in the same way as programmers should teach programming and computer scientists should teach computational thinking. After all, subjects specialists overcome the general and basic knowledge provided to teach those subjects in the school level, and have the passion for being subject-specific in many creative teaching ways. Their teaching and learning methods can vary a lot and can be applied differently for the exposure of different concepts. Lozanov's teaching methodology [18], for instance, is a student-oriented methodology, but it can change from one teacher to another, from one subject application to another. The teacher, for instance, can design the method application of making the students familiar with mathematical thinking, but can (and should) also design another application for making them familiar with CT.

#### **4.0 Computational Thinking v Mathematical Thinking: Similarities and Differences**

Apparently, there are many similarities between mathematical and computational thinking, but by no means can someone claim that they are exactly the same. MT is broader while someone should consider CT as a subset of mathematical thinking. If someone thinks about computational thinking using the approach of Tiensuu in 2012 [16], where computational thinking is part of problem solving, it can then be asserted that CT is a subset of mathematical thinking. However, mathematics is not (only) the science of solving problems, but (as many people joke about it), it rather is a science of creating a problem and then solving it.

Adopting the second approach of Tiensuu in 2012 [16], where computational thinking is a subset of computer science (mathematicians might agree more with that definition-approach), we can see more similarities with mathematical thinking. In both mathematical and computational thinking, there are also precise definitions and logical deductions. The logical deduction is rather a stronger concept in terms of mathematical thinking but it can still exist in pure computational thinking.

Moreover, in both ways of thinking, the ideas of classifications, conjunctures and organisation are the same. For example, in mathematics we set our domain of definition in the beginning and in programming there is a need always to become familiar with the basic operators and commands of each language. Both types of

thinking need organization - in mathematics it is called axiomatic (logic); but the same idea applies to CT as well. Finally, we can claim that there is a certain pattern in both types of thinking, comprising the three following constructs: i) the beginning of it- dissembling what we have in our hands, ii) the main part- the solution of it, and iii) the conclusion. Through these constructs, one can see that MT and CT include critical and creative thinking in their processes, i.e. in problem finding.

Often in their thinking mathematicians are somehow (but not entirely) different from computer scientists. Comparing and contrasting MT and CT, we can see that mathematical thinking has inside of it a beautiful and harmonic way of seeing the surroundings, something that probably computational thinking does not have in that extent, or it is not so obvious. Fibonacci sequences, for instance, can be viewed in musical scale and the result can be a wonderful piece of art; which could be viewed in a rather deterministic way through the lenses of CT.

Furthermore, in mathematics you can find the natural idea of abstract thinking, which cannot be found anywhere else in the same sense. Even computational structures possess abstraction in a concretized and certain way. In high level mathematics the interpretations of everyday life can be smashed and become universal. Five plus one is not always equal to six ( $5+1=6?$ ) but can be, for example, equal to two. High level mathematics provides the students with the chance to see the whole world through a prism, where they can observe different wavelengths and can see the white light having many colours inside. They can start associating this stage of thinking with philosophy and could understand the idea of cosmos. They can learn to accept different people, their different ideas, become more tolerant and understand the beauty of diversity. They will learn that there is not only one correct answer, because the answer depends on which is the current domain and on which topological space we are finding and solving the problem.

The beauty of abstract and versatile mathematical thinking cannot be found and experienced in the scope of CT, since the one is a subset of the other. Accordingly, the teaching and learning methods can vary a lot and can be applied differently for the exposure to MT and CT. Lozanov's teaching methodology [18], for instance, is a learning-centred method, versatile in its application to subject-specific knowledge. The method itself is being praised worldwide for having a significant effect for teaching languages at a large extent, but also science and mathematics successfully. Subsequently, it would be interesting to see the effectiveness of known teaching methods in the teaching of programming languages, mathematical or computational thinking.

## **5.0 Computational Thinking in Curriculum Design**

Immediate benefits that could be obvious from a further systematic literature review with well-defined inclusion/exclusion criteria and collection of experts/policy-makers opinions, are:

- a) a proposed definition/clarification of computational thinking and its scope, and

b) a suggested curriculum design for teaching CT with clarity and effectiveness.

Yet, there are many less consistently used terms while attempting to define conceptual thinking. These **non-consensus terms** can be classified into four areas:

- i) *Thinking terms*; there are suggestions that several specific types of thinking (logical, algorithmic, engineering and mathematical) should be included. Yet, of all the potential terms associated with thinking, only algorithmic thinking is the possible term which may be suitable for inclusion in a definition for computational thinking.
- ii) *Problem solving terms*; the idea that CT has some relationship to problem solving appears frequently in literature. The most frequently employed specific terms in discussions of general problem-solving skills are problem-solving, analysis and generalisation. Yet, problem-solving, while consistently used in literature, is a broad but not well-defined term. Analysis, used in the context of solution, is analogous to evaluation and used consistently. The term generalisation is used infrequently but there are descriptions of analogous processes. For this reason, the suitable terms for inclusion in a definition of computational thinking are evaluation and generalisation.
- iii) *Computer science terms*; CT has a deep relationship with computer science and some specific terminology has suggested to be include in a definition, such as systems design and automation as well as more general terms such as recursion and recovery through redundancy. Yet, none of them appears suitable to be included in a definition of computational thinking, since systems design and automation is evidence of the use of computational thinking skills, not a definition of it. Moreover, those terms that are interpretable as computer science content do not bring focus to the definition of computational thinking.
- iv) *Imitation terms*; terms modelling, simulation and visualisation appear frequently in literature. Yet, it is the manipulation of abstractions (models, simulations, and visualisations) that contribute to the development of computational thinking skills, but do not necessarily define it. That is, these tools are effective aids in developing computational thinking skills, but they may not be suitable for inclusion in a definition of computational thinking.

For this reason, Selby and Woollard in 2014 [19] gave the **proposed definition of computational thinking** that „computational thinking is an activity, often product oriented, associated with, but not limited to, problem solving. It is a cognitive or thought process that reflects the ability to think a) in abstractions; that is a process of making an artefact more understandable through reducing the unnecessary detail, b) in terms of decomposition; that is a way of thinking about artefacts in

terms of their component part which makes complex problems easier to solve, c) algorithmically; that is a way of getting to a solution through a clear definition of the steps by thinking in terms of sequences and rules, and reach a solution that works every time, d) in terms of evaluations; that is a process of ensuring that a solution for example an algorithm fits for purpose, and e) in generalisations; that is identifying patterns, similarities and connections, and exploiting those features quickly solving new problems based on previous solutions to problems.”

That is, CT is a focused approach to problem solving, incorporating thought processes that utilise abstraction, decomposition, algorithmic design, evaluation, and generalisations. Selby and Woollard (2014) [19] acknowledge that the definition can change as understanding of CT develops over the coming years.

## **6.0 Troubles with CT that Experts and Policy-makers Must Resolve**

In addition to the exact definition of CT, Jones (2011) [4] argues that Wing (2006) [1] never really explained how computational thinking differs from other kinds of thinking that require abstraction or a great deal of data. In addition, Jones (2011) [4] finds it difficult to accept that CT can be used to solve every problem as Wing [1] seems to inform us. Instead, Jones argues that there are a number of problems that would be seen to lie outside the realm of CT such as questions of aesthetics. Also, according to Jones (2011) [4] it seems that it would be difficult to solve something like a moral problem or a question of ethics based on the system of CT.

Since such problems are not a process of amassing data and drawing conclusions based on that, or even a process of conceptualising, rather they are a process of understanding personal values and ideas, or values that belong to a society as a whole. Moreover, according to Jones (2011) [4] and many other pedagogists, computational modellers and practitioners (see e.g. [12, 13, 15, 16, 17, 20]) there are problems that do not always have a concrete and reachable solution. After all, CT has limits and limitations that are in the nature of thinking itself. An effective, clear, consistent and relevant problem-based curriculum for CT should cater for all these challenges and bottlenecks.

Last, the authors believe that computational thinking and modelling, as subsets of mathematical thinking and modelling [20], could and should be combined with generative, parallel and manifold thinking [21] and should also be observed in its application in both informal and formal learning [22, 23] settings .

## **7.0 A Thematic Framework for Interviewing Experts and Policy-makers**

A thematic framework of semi-structured interviews of computational thinking experts is unfolded below.

*1. Understanding of computational thinking (CT) and its teaching*

- What is computational thinking?
- How CT is similar and/or different with coding, programming etc.
- To whom computational thinking and its teaching is important? Why?

*2. Attitude towards computational thinking and its teaching*

- How the field of computer science feels about CT and its teaching in general?
- How other fields of science feel about CT and its teaching in general?
- How do you personally feel about computational thinking and its teaching?

*3. Experiences on computational thinking and its teaching*

- What kind of experiences the field of computer science has about CT and its teaching?
- What kind of experiences you have about CT and its teaching?

*4. Lessons learned from computational thinking and its teaching*

- What kind of lessons the field of computer science has learned about CT and its teaching?
- What kind of lessons have you learned about CT and its teaching?

*5. Vision(s) of computational thinking and its teaching*

- How do you think the field of computer science sees the near and far future of CT and its teaching?
- How do you personally see the near and far future of CT and its teaching?

Influential policy-makers and international specialists on CT and related areas need to be contacted for questioning and/or interviewing for: i) accessing implications for educational policies and practices; ii) commenting on bottlenecks and barriers encountered in the implementation/evaluation of CT; iii) providing background information on the up-scaling and in the realisation of CT; iv) streamlining in-

depth knowledge by subject professionalism; v) outlining experiences from involvement in CT framework initiatives for education.

## 8.0 Summary, Conclusions and Future Research

Summarising, our preliminary literature review on CT pointed to further questions and considerations that should be taken into account for future research. According to Selby and Woollard (2014), based on literature review focusing on the term's consistency of use and interpretation, there appear to be three consensus terms that a definition of computational thinking should include: the idea of i) a thought process and the concepts of ii) abstraction and iii) decomposition.

The practical use of CT and computational modelling skills as part of digital competencies is an area where European education schemes seem to have a significant competitive edge. There has been much current emphasis on teaching CT from the point of view of educational research and curricula design. Henceforth, suitable pedagogical methods for teaching CT as part of mathematical thinking are in search for accelerating learning. There should be a future better, closer view of the results of literature reviews and the involvement of specialists and practitioners on CT for additional questioning and interviewing.

The questions we considered here tried to sketch the CT (skills and knowledge) domain and capture the essence of CT. If there are (also) experts (as we assume there could and probably even should be) that are not familiar with CT, they cannot probably answer to this kind of interview questions as we/they assume some degree of knowledge about CT and/or computational modelling. Such experts can be, for instance, human cognition or programming gurus, whose opinions can be very valuable for reaching possible outcomes and policies.

The potential experts to be used would not probably be able to give their reliable views and some potentially valuable input about a relatively *new old* concept such as CT, unless it is first defined for them. On the other hand, not been earlier acquainted with the exact and consistent definition(s) of something, one can actually and probably focus on something close but different, that is somewhat familiar with; and this prevents from addressing the essential research context.

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**Section 2**  
**e-Learning Issues**



# **Persistent Andragogical Patterns Across the Generations: From University Tutorial Classes to Postgraduate Online Education**

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## **Abstract**

The concept of design patterns in education raises the question of whether their validity can persist over a period of time or whether social and technological change means that yesterday's virtues are today's irrelevancies. Many see e-learning as something which is the latest and greatest form of education, possibly one that has made previous forms obsolete. However, when we look beyond the technology to the desired pedagogy, how much has radically changed? This paper compares two examples of how adults have been educated on a part-time basis in Britain; examples which are separated by 100 years. Because adults are involved, we should more properly talk of andragogy rather than pedagogy. It compares elements of University Tutorial Classes, which started in 1908 as a university outreach programme to deliver undergraduate level education to ordinary working people, with key features of an online Master's degree programme started in the 21<sup>st</sup> century. The University of Liverpool has been associated with both initiatives, and therefore provides a useful focus for comparison. On the face of it, the two initiatives could not be more different. However, if we strip away the differences in circumstances, motivation and technology, we find that the andragogical approach is remarkably similar. The same basic desirable elements are present.

**Keywords:** University Tutorial Classes, online education, andragogy, design patterns, discussions

## 1.0 Introduction

University Tutorial Classes, which commenced in 1908, taught largely social science subjects. They were fiercely non-vocational. They were attended by working people who had probably left school at the age of 13 or 14. The Master's degrees in Computing with which this author is associated are taken by people with honours degrees who study largely for vocational reasons. They have access to technology that the University Tutorial Class students could not have imagined.

Social and technological changes create new opportunities. The growth of the public library system from the second half of the 19<sup>th</sup> century, and the making available of scholarly papers and electronic books online in the 21<sup>st</sup> century are major landmarks, but it remains true that all higher education requires sources of research information. Today we may debate asynchronously over the Internet rather than face to face, but the value of discussion between adult learners, and their ability to learn from each other as well as from the teacher, persists throughout the generations.

Particularly in the field of technology, it is easy to adopt the view that there is constant progress. Yesterday's solutions quickly become out of date. The concept of design patterns in education raises the question of whether their validity can persist over a period of time or whether social and technological change means that yesterday's virtues are today's irrelevancies.

Increasingly, the general philosophical view that we can expect constant progress is not universally shared. An alternative view was set out by T.S.Eliot in his series of poems entitled *Four Quartets*.

“And what there is to conquer  
By strength and submission, has already been discovered  
Once or twice, or several times, by men whom one cannot hope  
To emulate – there is no competition –  
There is only the fight to recover what has been lost  
And found and lost again and again: and now, under conditions  
That seem unpropitious.”  
*East Coker* [1]

“We shall not cease from exploration  
And the end of all our exploring  
Will be to arrive where we started  
And know the place for the first time.”  
*Little Gidding* [2]

Many see e-learning as something which is the latest and greatest form of education, possibly one that has made previous forms obsolete. However, when we look beyond the technology to the desired pedagogy, how much has radically changed? The examples set out in this paper deal with the education of adults, and

hence it would be more appropriate to talk of andragogy rather than pedagogy. The question is whether it is possible to examine instances of the education of adults separated by a century and discern persistent patterns which indicate that certain examples of good practice do not go out of date, even when they are operating in very different circumstances.

This paper is not about specific design patterns, but about more general persistent andragogical patterns in the way learning is delivered to adults. If certain practices remain valid a century apart, perhaps this provides some confidence that many specific design patterns will maintain their validity over the years.

## 2.0 University Tutorial Classes

Until late in the 19<sup>th</sup> century, there were just four universities in the whole of England and Wales – Oxford, Cambridge, London and Durham. Attempts were made to make university level classes available to the general public through the university extension movement, from around 1867 [3]. It would typically arrange a series of lectures away from the university towns. One of the fathers of university extension, the Cambridge academic, James Stuart, wanted “to establish a sort of peripatetic university the professors of which would circulate among the big towns” [4]. These classes tended to attract minimal subsidy and hence fees (also referred to as ticket prices) needed to be set at a level which would recover the full economic cost. This meant that attendance at lectures was restricted to those who could afford them, or they needed an attendance of several hundred to make fees more reasonable [5].

As the 20<sup>th</sup> century dawned there was an increased interest in extending at least some of the benefits of higher education to ordinary working people, and in 1903 the Workers’ Educational Association (WEA) was formed with a good measure of cross-party support. At around the same time, a number of civic or red brick universities were being established in major industrial cities, usually after going through a form of apprenticeship as university colleges. The University of Birmingham (1900) was followed by Liverpool, and the Victoria University of Manchester (1903), Leeds (1904), Sheffield (1905), and Bristol (1909). James Stuart had been very supportive of the establishment of university colleges, and it does seem that Cambridge University’s extension work in Liverpool generated public support for the eventual establishment of a university in the city [6].

The first University Tutorial Classes were held in January 1908 in Longton, Staffordshire and Rochdale in Lancashire. The original idea was to have a maximum enrolment of 30 people for each class although, in the event, they were oversubscribed. Attendees committed themselves to study for at least two years (later this was to be increased to three years), and to contribute essays. Each week there would be a lecture, followed by a period of discussion. Oxford University was initially the main academic promoter of the tutorial classes, and the tutor in Rochdale was funded by a donation of £300 from New College [7]. Cambridge

followed in 1909, organising classes in Leicester, Portsmouth and Wellingborough [8].

Soon the Tutorial Classes, which were meant to be of an honours degree standard, were put on a more formal organisational basis, with local joint committees being set up to run them, containing both WEA and university nominees. They were supported by a Central Joint Advisory Committee on Tutorial Classes from 1909 [9]. Most importantly, the Board of Education was persuaded to pay grants to support the Tutorial Classes, and this made student fees more affordable. Often only a nominal payment was required. Some scholarships were made available by charitable trusts [10]. At the University of Liverpool, the scholarship amounted to £13 and 2 shillings [11]. The Universities of Oxford and Cambridge established a tradition of each hosting a residential Summer School for Tutorial Class students.

All English universities began to organise Tutorial Classes. They were joined by the university colleges which made up the University of Wales, and by Queen's University, Belfast [12]. There was limited support for the initiative in Scotland [13].

Appropriately enough, T.S.Eliot taught one of these classes in Modern English Literature in Southall under the auspices of the University of London, commencing in 1916 [14]. The first one promoted by the University of Liverpool was held in Birkenhead, starting in 1909, on the topic of The Evolution of Modern Social Conditions [15]. Later that year, the first class in the City of Liverpool was launched, with students studying The Social and Political History of England Since the Eighteenth Century [16]. In 1910 a Joint Committee on Tutorial Classes was set up with seven representatives nominated by the WEA and seven by the University of Liverpool. Classes were soon being offered in Accrington, Barrow, Crewe, Lancaster and Wrexham [17].

Liverpool established its own Summer School in 1923, to be held each year in Chester [18], and "by the eve of the Second World War there were no fewer than 67 classes, many of them in their 4<sup>th</sup>, 5<sup>th</sup>, or 6<sup>th</sup> years, with a total of 1,056 enrolled students. More than one-third of these classes were in Liverpool itself. The work was supported by grants from the University, the Board of Education, and the Local Education Authorities" [19].

The high tide of the Tutorial Class movement was probably reached just after the Second World War. In 1947-48, Liverpool was sponsoring 113 Tutorial Classes with a total of 1,631 students [20]. Thereafter, students began to show a preference for shorter courses, and there were more opportunities for bright children to stay on at school and apply for entry to higher education courses which led to a qualification.



### 3.0 Comparison With Online Postgraduate Education

In Table 1, there is a brief summary of some of the differences between Tutorial Classes and the kind of postgraduate online education offered by the University of Liverpool. There follows a more detailed discussion.

Table 1: University Tutorial Classes and Postgraduate Online Education

	<b>University Tutorial Class</b>	<b>Postgraduate Online Education</b>
Funding	Significant public subsidy	Student fees cover the full economic cost
Subjects	Social Sciences, Economic History	Business/Management, Computing, Public Health
Motivation	Militantly non-vocational	Predominantly vocational
Sources of Research Information	Public libraries, boxes of books	University online library, the Internet
Teacher Supplied Information	Lectures	Written lecture notes or video lectures
Discussion	Face to face	Asynchronous online
Assignments	Essays	Essays, practical exercises or group projects

### 4.0 Funding, Subjects and Motivation

Those who enrolled in both programmes of study would be mature adults. Beyond that, the differences could not be more stark. That is why it is probably a good test of whether there are common features which not only persist across the generations, but can be applied to adults in quite different situations.

University Tutorial Classes would have been attended predominantly by employed people with modest incomes who lived within easy travelling distance of the study centre. They would have typically left school at the ages of 13 or 14. The organisers saw themselves as promoting working class education, and some seemed to be uncomfortable if too many people in white collar occupations

attended the classes. Significant public subsidies were made available so that cost would not be a serious obstacle to participation.

Online programmes at the University of Liverpool are, by contrast, completely self-funding out of fee income. This inevitably means that participation is limited to those who can pay the necessarily high fees, or who can persuade their employers to pay for them. Students would typically be already educated to honours degree standard. The reluctance of governments to subsidise online postgraduate education is no doubt influenced by the fact that students are predominantly vocationally motivated, and can reasonably expect a Master's degree to advance their career. It is often argued that where the benefit is largely to the individual rather than to society, public subsidy cannot be justified. There is also the factor that online degrees are now taken mainly by students resident outside the United Kingdom (and often outside the European Union). The case for public subsidies for overseas students would be weak.

Those participating in Tutorial Classes usually had little secondary education. Albert Mansbridge, the secretary of the WEA, was a key figure in getting the universities, trade unions, educational civil servants, politicians and church leaders behind the University Tutorial Class initiative. He pointed out that "the range of subjects is limited to those which do not demand a long period of school education; for instance, mathematics and languages are beyond this range, and the same may be said generally of pure and applied science, although some of the more successful classes have been held in biology" [21]. Classes were more likely to focus on the social sciences and humanities, with Economic and Industrial History being particularly popular subjects.

By contrast, online postgraduate degrees tend to concentrate on vocationally relevant subjects. Those which have proved to be particularly successful when delivered online are Business/Management, Computing/IT, and Public Health. At a Master's level they require a good level of prior knowledge or academic ability.

The attitudes of Albert Mansbridge, and the trade union leaders and academics who supported him, were militantly non-vocational. We could say of some of them that they supported the idea of a liberal education, one which was pursued for the sake of learning alone rather than for vocational advancement. "In its purity, Adult Education has little or nothing to do with any ulterior motive", and wanting to progress one's career was such a motive [22]. For these reasons, Mansbridge was opposed to the issuing of certificates of attainment in Tutorial Classes lest they be used for vocational reasons [23].

He claimed that "certificates would tend inevitably to attract an inferior type of ambitious student – not slow to appreciate the fact that the certificate attached to the highest type of non-technical education outside the Universities would stand him in good stead for purposes of professional advancement. The repudiation of certificates has given great encouragement to those who believe that true study is its own sufficient reward" [24] (Mansbridge, 1913, pp.57-58). This has always

been an unusual argument, because the academic supporters of this idea have never been slow to use the degrees they have obtained to advance their own academic careers.

There was another anti-vocational motive, which was based on a particular view of class loyalty. The WEA secretary wrote about “working class lads who pass up the ‘ladder’ of education to the University...It is one of the most poignant causes of regret that such scholars turn to work in the professions and cease to be interested in their own people” [25]. There was a strong school of thought that working class students should get an education and then return to their own communities to become officials in trade unions, the co-operative movement, or the Labour Party. There was very limited support among such people for the idea of upward mobility.

Although it was sometimes claimed that this attitude was shared by students who participated in Tutorial Classes, it is likely that they had a range of views on the subject. The Cambridge Tutorial Class archives show that, in a survey prior to World War II, “the students’ view was that ‘no sane person would re-enter a Coal Pit as an employee if he could avoid it’, or ‘locals would have regarded [a return to previous employment] as a sign of failure’. Apparently only one student ‘never regarded the obtaining of a job as the primary end of education’...Many of the first students afterwards regretted that they had not been allowed to take a degree. The gap between the thinking of the University and the adult students shows in itself how important it was to bring the two sides together” [26].

It can be seen that Tutorial Class and online Master’s students are, in many ways, as different as it is possible for two groups of learners to be. However, it is now time to look at those aspects of the higher education of adults which may be similar, and capable of persisting across the generations.

## **5.0 Sources of Research Information**

Higher education courses expect students to read what others have written on a particular topic so that they can analyse and critique it before drawing their own conclusions. That requirement has not changed in 100 years. The sources of information that are available to students are, however, influenced by social and technological changes.

The Public Libraries Act of 1850 was aimed at establishing publicly provided institutions where books would be made available to the working classes [27]. The first of these libraries was opened in Manchester in September 1852 at a ceremony attended, among others, by the Earl of Shaftesbury and Charles Dickens. Liverpool followed a month later with a public library built under powers bestowed by a local Act of Parliament [28].

These libraries were to provide important support to university extension, and later to the University Tutorial Class initiative. Tutorial Classes were also supported by

the Central Library for Students in London, which was initially funded by grants from charitable bodies [29]. Each sponsoring university usually provided a box of books for each class [30, 31]. This did not usually involve the provision of multiple copies of a particular book. Occasionally it was possible to get cheap editions of particular works published, which students would buy themselves [32].

Social, economic and technological realities provide both constraints and opportunities for education but, surprisingly, they often do not change what is desirable. Online students at the University of Liverpool have available to them a range of published sources which a Tutorial Class student could only have dreamed about. Universally accessible websites are one important source of information.

However, a key change which provided a boost to online education was the decision by the publishers of academic journals and books to make them available in an electronic form to universities who paid a subscription. Where universities like Liverpool made the additional investment to make these resources available outside a local campus network, it opened up a vast array of quality academic material to online students anywhere in the world who had an Internet connection and an appropriate password.

I think it is fair to say that University Tutorial Class students would have loved to have a similar access to published information. What is desirable has not changed significantly, only what is possible at different points in time.

## **6.0 Teacher Supplied Information**

University Tutorial Classes always started with a lecture lasting for one hour. This was the main method by which the tutor presented information to his or her students. It would have been very unusual for all members of a class to each have a copy of the same book, so that it could be used as a textbook.

In an online degree, there are more options. Students at Liverpool would typically be asked to each obtain a copy of a textbook in paper or electronic form. They would be referred to a range of references which would be readily accessible over the Web, or in the electronic resources held by the University library. Nevertheless, it would still be common for students to be presented with a series of lecture notes in electronic form produced by some member of the teaching staff. These summarise key points and provide specific information which will be needed to complete assessments. Videos of lectures may also be available, but always backed up by written material to improve accessibility for those with disabilities.

There are different views on the role of the teacher, but it is difficult to imagine a situation where it is not useful for the person supervising the class to provide some information to adult students. This remains something of a constant across the generations, although technology will influence the form in which that information can be presented.

## 7.0 Discussion

In Tutorial Classes, a period of one hour was scheduled for discussion following the lecture, although sometimes this session was extended until such time as the hall caretaker's patience was exhausted. The inclusion of the word "tutorial" in the title displayed the influence of Oxford University in launching this initiative.

What became known as the Oxford tutorial usually involved a tutor meeting with one student or a very small number of students for one hour. Those students would learn from an expert, often through one of their number reading an essay which the tutor and the other students would discuss. One of the main aims has been to get students to think for themselves [33].

Of course, such a method of teaching is very expensive, and there were nothing like enough teaching resources devoted to University Tutorial Classes to make it possible. What was transferred into Tutorial Classes was the slightly different concept of a group discussion lasting one hour, with one-to-one interaction being exceptional.

There is another reason why the Oxford tutorial did not migrate well into the field of adult education. It was typically based on the idea of learning from an expert in the field. Mansbridge asserted that in the Tutorial Classes "each student was held to be a teacher and each teacher held to be a student" [34]. This is a common feature of andragogy. Students are likely to possess valuable practical knowledge about how theories turn out in practice. They may be able to produce examples which challenge or confirm generalizations. Adult students are therefore often just as likely to learn from each other as the teacher.

It is not unusual for the tutor or instructor to become the guide on the side rather than the sage on the stage. In modern online education, the instructor will often be described as the moderator of a discussion, and it is in this kind of role that a tutor 100 years ago would be urged to ask questions and guide discussion when interaction flagged or was in danger of getting too heated [35].

Online postgraduate education, through the wonders of the Internet, has escaped the restrictions of geography. Tutorial Classes were attended by those who could travel to a particular location once a week. Online classes can attract participants from all over the world. Asynchronous discussions, where two or more parties do not need to be present at the same time in order to communicate, overcome the problem of students living in quite different time zones.

In Liverpool's version of online education, discussion is central, to the extent that a significant portion of total marks are devoted to this assessed element. Students must show that they can put forward a point of view in answer to a specific question, and then defend, amend or abandon that position in the course of discussion. They learn how to think rather than what to think.

Again, we can see common patterns in examples of the education of adults a century apart. The main difference is that technology has made asynchronous

participation feasible. That would have been a great benefit to busy working adults at the beginning of the 20<sup>th</sup> century.

## **8.0 Assignments**

Students in University Tutorial Classes wrote essays as part of what we would today describe as formative assessment. They received feedback to help them learn, but it did not contribute towards obtaining a qualification.

Assessment in modern online education is more summative. Students need a graded qualification to achieve vocational advancement. Fortunately, they can do this without being accused of having an ulterior motive, or of being an inferior type of ambitious student.

Essays are still used for assessment, but because subjects are often more technical, assignments can also involve the production of an electronic artefact, such as a computer program, which can be submitted online. Group work is something that has been made possible for part-time students by changes in technology.

Students attending Tutorial Classes a hundred years ago would probably have enjoyed working in groups on projects, but it would have been extremely difficult for groups to meet together outside the one session per week on which they attended a lecture and discussion. The Internet has meant that asynchronous collaboration is possible throughout the week in moments that are convenient to each student, even though they may live on opposite sides of the world.

We have retained what was valuable practice in earlier times, but technology has once again now made possible what was probably always desirable.

## **9.0 Conclusion**

Mansbridge thought that the ideal size of a Tutorial Class was 24 [36]. In the Liverpool online courses, the class is rarely allowed to exceed 20. This is a number at which discussion is manageable. Even in the detail, some things do not change. Many things do change, and sometimes for the better. At other times, change takes place because of a rather shallow attachment to constant novelty. Things of value can be discarded carelessly.

What is important in these circumstances is to have a balanced and critical attitude towards new initiatives. If it is not broken, it is often unwise to try and fix it. Across the generations, the value of certain things does not diminish, although social and technological change often makes possible that which we always wanted.

There is every reason to believe, therefore, that design patterns in education can provide solutions of persistent value.

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# Heuristics for Ethical Development and Use of MOOCs

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## Abstract

It is widely acknowledged that technology offers a chance to redefine, or at least change, learning and education for the better. Massive Open Online Courses (MOOCs) can be defined as learning events that are conducted via the Web, which can accommodate large numbers of people, typically ranging from a few hundreds of participants to over a hundred thousand. A classification of MOOCs suggests that there are two general types: xMOOCs and cMOOCs. Different types of MOOCs require different levels of participatory literacy skills, motivation and self-determination. Although it is recognised that MOOCs embody a potentially exciting opportunity to use technology to realize many benefits of universal higher education there are also significant ethical concerns that arise in their development and deployment.

In this paper we customize a theoretical framework developed by the US Content Subcommittee of the ImpactCS Steering Committee that specifies traditional moral and ethical concepts, which can be used to cater for the teaching and learning of the social, legal and ethical issues concerning MOOCs. An application of these conventional and generic ethical concepts can help flag issues, amongst others, such as: intellectual and pedagogical integrity; privacy, identity, and anonymity; intellectual property rights and plagiarism; and the digital divide. In the design and utilisation of MOOCs developers, content authors, tutors and participants must be aware of these ethical and moral concepts, as presented in this paper, in order to become more responsible professionals and citizens in general. We propose a set of heuristics for ethical development and deployment of MOOCs.

Keywords: MOOCs, ethics, quality of life, use of power, risks and reliability, privacy, property rights, equity and access

## 1 INTRODUCTION

The all-pervasive use of computers and the Internet in every facet of our personal lives and businesses has altered our lives at work and home. It has reshaped the landscape, and the functioning of the economy, health, industry, agriculture and many other spheres, including education. The phenomenon of Massive Online Open Courses (MOOCs) in education has led to a trend towards greater openness in higher education. A MOOC is an online course aimed at unlimited participation,

self-regulated and open access via the web. The development and deployment of computers, has given rise to questions of right and wrong. Computer Ethics can be defined as [1]: “.... *The analysis of the nature and the social impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology*”.

The study of computer ethics can be viewed as [2]: “....*The study of the ethical questions that arise as a consequence of the development and deployment of computers and computing technologies. It involves two activities. One activity is identifying and bringing into focus the issues and problems that fall within its scope, thus raising awareness of the ethical dimension of a particular situation. The second activity is providing an approach to these issues, a means of advancing our understanding of, and suggesting ways of reaching wise solutions to these problems*”.

## **1.1 MOOC Models**

MOOCs have been broadly characterised as being cMOOCs (the *c* term meaning connectivist) or xMOOCs (the *x* term denoting transfer) [3]. Some developers, facilitators and researchers may argue that this is too simplistic a view and that MOOCs exist more in a spectrum as opposed to being categorised as one of two distinct types [4] [5]. The former, is based on principles from connectivist pedagogy; whereas the latter will typically centre on instructor-guided lesson(s).

### **1.1.1 xMOOCs**

A learning management system will accommodate an xMOOC, which characteristically features recorded video lectures and machine-graded assessments. In addition, threaded discussion forums can possibly facilitate student interaction and the potential for peer graded assignments. Succinctly put learning activities in xMOOCs are mainly viewed as being *consumptive*. Content is prescribed by the developers, and participant mastery or understanding of the content is measured via tests, with almost no direct interaction between an individual participant and the instructor accountable for the course. Although there are subtle, but in some cases stark, differences between instances of xMOOCs, they have typically a number of common design features [3] [6] [7]: Computer-marked assessments; Learning materials; Moderation; and Learning analytics.

### **1.1.2 cMOOCs**

Connectivist MOOCs are based on principles from the learning theory that is connectivist pedagogy [6] [8]. They are characteristically decentralised, with an emphasis on the *production* of content as opposed to the consumption. In this

approach the participants are encouraged to pursue their own goals and forge their own learning paths, so traditional assessments are rare [9]. Therefore, unlike xMOOCs, cMOOCs do not make use of a formal teacher-student relationship, either for delivery of content or for learner support. Learning is facilitated through open and connected social media because cMOOCs are characteristically not institutionally based or supported, thus do not make use of a shared platform(s). This permits autonomous learners to be networked with each other. This connection allows for a sharing of knowledge through participants' personal contributions. The crucial design practice is that all participants contribute to and share content. Although there are variations between instances of cMOOCs, they have typically a number of common design features [9] [8] [10]: The use of social media; Participant-driven content; Distributed communication; Students as assessors; and Use of key-words.

### **1.2 Lane's Classification of MOOCs**

An alternative classification of MOOCs suggests three general types [11]: Firstly, **Network based MOOCs**, where the "*goal is socially constructed knowledge developed through conversation and exploration*". Secondly, **Task based MOOCs**, which "*emphasise skill development through the completion of tasks*". Finally, **Content based MOOCs**, where the focus is on "*transmitting content, usually automated assessment, not having to be participatory*". This classification seeks to focus on the instructor/teacher who has designed the MOOC.

### **1.3 Clarke's Classification of MOOCs**

Looking at MOOCs from a pedagogical, and not an institutional perspective, suggests taxonomy of eight types of MOOC [12]: 1) Transfer MOOCs; 2) Made MOOCs; 3) Synch MOOCs; 4) Asynch MOOCs; 5) Adaptive MOOCs; 6) Group MOOCs; 7) Connectivist MOOCs; and 8) Mini MOOCs. New MOOCs may initially developed largely based on one of the categories outlined above. However, in practice a combination of elements from each category is implemented and extended, customised, reshaped in the course of implementation based on feedback, insights gained and in-depth analysis.

## **2 THEORETICAL FRAMEWORK AND ETHICAL CONCEPTS**

### **2.1 The US Content Subcommittee of the ImpactCS Steering Committee**

In the development and deployment of computing technology a number of social, legal and ethical issues can be invoked. Legal issues can be resolved via the use of legal doctrine, which is a framework presenting a set of rules, procedural steps, or

test, through which rulings can be determined in a given legal case. In the same vein the most important ethical issues surrounding the deployment and development of computer technology can be resolved by making a rational appeal to traditional ethical principles and theories and so extend them to the use of new technologies. The US Content Subcommittee of the ImpactCS Steering Committee [13] advocated a framework presenting a set of traditional moral and ethical concepts that could be used to flag potential ethical issues in a given case. In terms of personal and professional responsibility, the committee recommended the following six traditional moral and ethical concepts: 1) Quality of life; 2) Use of Power; 3) Risks and reliability; 4) Property Rights; 5) Privacy and 6) Equity and Access.

In order to become a responsible computer professional, the ImpactCS Steering Committee argued that one must be able to examine the standards for the rightness and wrongness of actions. For a particular issue, for example, privacy in corporate records or risks in medical technology, it will cover many levels of social analysis (individual: race, class, gender and culture; communities and groups; organisational; institutional; and national and global). In addition, it will cover several different ethical issues and will be spread across differing implementations of the technology.

## **2.2 A theoretical framework for the teaching and learning of ethical issues concerning MOOCs**

The theoretical framework developed by the US Content Subcommittee of the ImpactCS Steering Committee has been customised. It specifies the six moral and ethical concepts, listed above, that can help identify the social, legal and ethical issues invoked by the development and deployment of MOOCs. We added commentaries, below, which lead to a set of heuristics for ethical development and use of MOOCs, in Section 4.0.

## **3 THE ETHICAL ISSUES INVOKED BY THE DEVELOPMENT AND DEPLOYMENT OF MOOCs**

In order to become more responsible developers, facilitators and students in general it is imperative that all are aware of the moral and ethical concepts specified in the framework. It is only through comprehending the issues raised by the framework that developers, trainers and students can achieve a better understanding of the social, legal and ethical issues concerning the delivery of education via MOOCs.

### **3.1 The Quality of Life**

A traditional classroom environment is held as a relatively private space where students can safely explore and investigate many topics without having to bare their experiences to public inspection. Exposure to an unlimited number of

participants in a learning community may well unsettle some students consequently leading to their disengagement from the MOOC [14]. MOOCs endorse the notion of openness to learners. More often than not this is realised through aspects such as open entry (where no formal admission requirements are required for registration on a MOOC). In contrast to the enrollment process at a conventional campus college/university, where typically the registration will require formal admissions requirements to be met, in the case of MOOCs eligibility may not solely depend on academic qualification prerequisites being met but may also be contingent on an assortment of personal circumstances that may determine the suitability of an applicant. In direct financial terms access and use of MOOCs is often free to students. However, there must be an acknowledgement of sundry costs whilst engaged with MOOCs, for example time spent on a MOOC “is taken from other alternative activities such as employment, family responsibilities, or alternative forms of education [15]. Engaging in MOOCs studies requires self-motivation and commitment even if the purpose of the learner may be curiosity for learning at the one end or opportunity for professional updating and career progression. Whichever end of the spectrum the underpinning motivation is improvement of the quality of life. In Northern Sweden MOOCs were piloted for addressing the needs of off-campus students at community learning centers by forming “blended” or “glonacal” courses [16]. Learning center staff identified learning needs in the regional development context and a suitable MOOC course was found and marketed locally as a study circle function with 3 or 4 participants meeting weekly or bi-weekly at the learning center. Students registered for the MOOC and a study circle leader was appointed among the learners. Local content was added to the course, such as visits to workplaces relevant for the course or an expert visiting the group for discussions in person. A course certificate can be obtained from the MOOC platform. Cooperation with a Swedish university arranging a local examination is an alternative option. The results showed that the learning centers found a new tool for addressing local learning needs without being dependent on education offerings from regional or national universities. It gave the asynchronous MOOC course a social face-to-face support environment and a widened social network, since students had two layers of peers – internationally through the MOOC course forum and locally in the study circle.

### **3.2 The Use of Power**

Academics/providers need to “avoid any exploitation, harassment, or discriminatory treatment of students.” A key question in considering the ethics of a MOOC is to probe whether the creation of the course, its design, curriculum, and the experiences provided for students are being done “primarily to educate students and not principally for some other personal or institutional goal likely to compromise the educational outcomes” [18]. It has been noted that higher education institutions have transformed into commercial enterprises thus affecting the original intentions behind the launching of MOOCs. Thus two main commercial actions are invoked: “*on the one hand, free MOOCs have started to be employed as marketing tools in order to drive university recruitment at an international scale. Meanwhile, on the other hand, new fee-based models of*

*MOOCs for accreditation via formal assessment have been born. These steps are gradually changing the initial ethical agenda set for MOOCs*” [18]. In education and its wider context there exist “cultures of silence”. What is required are to find ways of breaking that silence, and giving voice to the marginalised and to oppressed groups. “*This raises a paradox insofar as it confirms the negativity of a culture of silence. In some circumstances, the use of silence is in itself an exercise of power, and this is applicable to the classroom as well as to the wider community*” [18]. MOOCs, connectivist cMOOCs in particular, possibly offer a means for disrupting the power relationships generally present in higher education, via the use of technology to enable a more democratic and collective engagement. Whereas it is recognised that “*while xMOOCs are at risk of perpetuating pre-existing disparities in power, the group culture of a cMOOC can also be disempowering if the academics responsible are not alert to the issue and responsive to the needs of the majority of their students*” [15].

### **3.3 Risks and Reliability**

The quality of learning materials is a very important issue concerning the development of MOOCs. Co-creation of solutions to problems and feedback/assessment by peers may jeopardise the correctness and quality. Many MOOCs though have little or no qualified tutoring or guidance, just online areas for student communication and learning materials resulting in learning engagement being out of the control of the organisers [19]. The credibility and the value placed on MOOC assessments can be comprised by the threats of impersonation and exam cheating. It is imperative that assessors ensure that the registered candidate is indeed taking the assessment and not an impersonator [20]. One possibility, akin to distance mode courses run in the past at Middlesex University London, is to set specific dates for particular assessments, which could be invigilated by independent third parties, such as the British Council. Review and improvement based on analytics is vital to ensure the efficacy of a MOOC for delivering effective education. However, it must be noted that as students engage with a MOOC it is likely that the data garnered on them, by a MOOC provider, will grow in scope. The collection of personal data on students may well be useful for validating achievement but could, concurrently, potentially subject them to the risk of identity theft or other unintended breaches of confidentiality [21].

### **3.4 Property Rights**

With regards to MOOC course production, the use of copyright-protected third-party content needs to be used with care. The different course materials used e.g. audible, viewable, and downloadable third-party content, in lecture videos and in all supporting materials, will be subject to copyright law. MOOC platform providers must handle the institution as a publisher. A majority of contracts will state that the university/provider is responsible for reviewing and obtaining any necessary licenses, waivers, or permissions for use of third-party content. Plagiarism can be succinctly defined as representing someone else’s words or thoughts as one’s own. MOOCs attract students from around the world, and

different cultures have different perspectives and tolerances on plagiarism and ownership in education.

### 3.5 Privacy

When entering into a MOOC, most students recognise that they will become identified to other students and to their teachers. By necessity, students are rarely able to remain anonymous in this context. Experience has shown that anonymity is not conducive to effective social engagement in a learning context and as MOOCs increasingly become associated with certification and qualification systems, the need to accurately identify individuals will only grow. What students do not expect is that their use of the MOOC will translate into other, completely unrelated, uses such as marketing services offered by commercial partners especially when that might imply a personal endorsement taken without explicit permission.

### 3.6 Equity and Access

Studies investigating the demographic profiles of characteristic MOOC participants indicate that they typically have good prior educational attainment, thus a high level of information handling skills, in order to successfully participate in a MOOC [4]. MOOC participants require a certain level of digital and information literacy in order to make use of the online materials. Can MOOCs allow for a future of equal educational opportunities for all, or is a digital divide being widened? An internet connection is required in order to access a MOOC course. If their hardware is outdated, their internet connection poor or they cannot afford to pay for a flat rate, then their opportunities for accessing content are more limited than those of more materially well-off users with the latest technical equipment [22]. Proponents of MOOCs point to the equity provided these online courses but it must be noted that MOOC providers need to deal with potentially vulnerable groups; the issue of the digital divide in terms of access to technology and also with respect to the level of digital literacy needs to be addressed. The development of MOOCs is entrenched within the principles of openness in education. This value demands that knowledge should be shared freely, and the desire to learn should “*be met without demographic, economic, and geographical constraints*” [23]. There are eight ethical considerations concerning e-learning [26], one of which is cultural bias that also apply to the ethics of MOOCs. Several studies have been reported and cited that suggest consistent differences between Western and Eastern education [24] [25]. The latter is often viewed as a pedagogical culture that emphasises: group-based, teacher-dictated, centrally organised learning with examinations as the primary tool for assessment in order to demarcate performance. In addition, the teacher is viewed as a ‘*sage on stage*’, whose authority and knowledge is to be left unchallenged and deference to be shown. The former typically transforms the role of the teacher, shifting from lecturing to be one of coaching and guiding thus enabling a self-development process as dialogue and interaction are urged in the learning process. Eastern students, in online learning environments, tend to have a tendency of collectivism, uncertainty avoidance and an acceptance of higher degree of unequally distributed power (high power distance). In contrast, Western students typically desire more interactions among the student cohort and are

comfortable with the nonlinear nature of their online courses. Poor language competencies tend to amplify other cultural problems when trying to complete a web-based course thus non-native speakers tend to withdraw from equal participation [25].

#### 4 HEURISTICS FOR ETHICAL DEVELOPMENT AND USE OF MOOCS

A set of heuristics for individuals and institutions are provided as a starting point for developing ethical MOOCs and associated activities.

1. The efficacy of MOOCs, as a means of delivering effective education, the development process for MOOCs must encompass information literacy instruction. MOOC developers and facilitators should be ready to develop practices to support and encourage learner participation, and to identify the importance of **learning, literacy and digital skills** at work within the MOOC environment [9].
2. A **MOOC code of ethics** must be fastened onto an online course in order to guide learners and facilitators about being and behaving morally responsible in specific virtual environments. The code of ethics must explicitly state what acceptable and intolerable actions are with regards to issues such as: harassment, privacy, intellectual property (plagiarism and ownership), etc.
3. Examinations can be invigilated at regional test centers, partially **addressing issues of impersonation**. The use of technologies, for example, webcams, or monitoring keystroke recognition [mouse clicks and typing styles] can facilitate the completion of assessments at home, allowing those with mobility issues to study from home thus **widening participation**.
4. The design of MOOCs should consider a blend of teaching pedagogies and learning styles in order to **address the spectrum of diversity** in the MOOC cohort. This would permit ethical consideration of *cultural bias*, which applies to the ethics of MOOCs, to be addressed. For example, language barriers can be alleviated by translating teaching materials and incorporating in the design of a MOOC, elements of asynchronous online learning. Locally relevant case studies and examples can enhance understanding and aid participation and learning. These steps could be achieved, for example, with the use of written communication as the alternative form of communication.
5. With regards to **acknowledging and respecting property rights**, course components have an open license and are correctly attributed. Reuse of material is supported by the appropriate choice of formats and standards [26].
6. All material presented on a MOOC must **meet accessibility standards**. For example, the design should include image description for alt text screen readers, video captioning and transcripts for video and audio



content. Another example is the use of alt text, where all images contain a corresponding description that expresses the context of the image, thus permitting it to be read aloud by a screen reader or displayed as text if the user's device cannot display the image.

7. Institutions need to explicitly state the strategic goal to developing and running the MOOC. If the aim is to primarily educate students then fine, else if it is for other personal or institutional goals then these should be clearly declared in order to **avoid conflicts of interest and student exploitation**. If MOOC participants are being used as subjects in a research experience, then **consent** must be sought.
8. Ensure the protection of the data used from MOOCs. For example, clearly state to learners how the data garnered on them is in accordance with **data protection principles**, for example, as stated in the UK Data Protection Act, 1998.

## 5 CONCLUSIONS

The rationale of adopting and applying the theoretical framework developed by the US Content Subcommittee of the ImpactCS Steering Committee was to identify the ethical issues that can be invoked in the development and deployment of MOOCs. In doing so the authors conclude that the importance of ethical considerations in the processes of design and implementation can be brought to the attention of the MOOC community. Thus help raise the visibility of ethical design. The paper contributes to the current pedagogic discourse relating to the relatively sudden growth of MOOCs. In particular, set of heuristics for the development and deployment of MOOCs has been proposed which will raise awareness of the issues and help guide developers and consumers (students) of MOOCs. Future work will seek to apply *legal principles* to the development and deployment of MOOCs. A comparison between the ethical and legal considerations may permit bad laws to be flagged, i.e. those legal regulations that provide no moral guidance.

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**Section 3**

**Encouraging  
Employability**



# Formative Assessment with Open Badges

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## Abstract

The paper describes the experience of one of the authors using open badges with various levels of undergraduates at Southampton Solent University, to encourage non-assessed participation.

The practical issues in starting this approach are discussed – including the advantages and disadvantages from the perspective of both the students and of the lecturer. The link with automatic testing and previous non-attendance could be measured. The views of the students and lecturers are discussed and the technical issues are also considered.

**Keywords:** Open Badge, Continuous Professional Development, CPD

## 1.0 Introduction

To address the need to encourage attendance and participation by students, Open Badges have been used in various countries throughout the world [1].

Open Badges specifications were originally developed by the Mozilla Foundation in 2011 [2] launching the Badge Alliance consortium into 2014 [3] to further develop the badge ecosystem and specification, in January 2017 the Open Badge Standard moved over to IMS Global [4].

The Open Badges are awarded by the appropriate institution, college organisation on attainment of certain competences or attendance. These are like the traditional Scouts, Girl Guide, and Cubs or Brownies badges that are sewn onto their uniform [5].

The Open Badges are e-badges which are collected in the recipient's equivalent to a backpack such as Mozilla Foundation Backpack [6]

There is no cost to the recipient of the badge. The badges can include the logo or identification of the company, university or school, and can be had in a variety of shapes and colours. The basic information about the "achievement" of the recipient is shown on this Open Badge, such as the organisation, skills acquired or attendance at a particular event, possibly with a date. There could be a level of these skills or attendance, indicated by say a surround of bronze, silver or gold to the Open Badge.

Further information can be obtained about the purpose of a badge. This could be the date of the event, and expiry date of a skill, the title, description and possible a link to a website for further details.

The additional information provides the recipient with an e-record of their achievements, similar to more conventional paper-based or electronic Continuous Professional Development (CPD) information.

The aim is the motivation of recipient, such as the use of physical badges of Boy Scouts etc. to encourage them to collect further badges [7], so there is a similar incentive with Open Badges.

These Open Badges can be easily awarded. If the person awarding the Open Badges must have a list of those already registered on an awarding platform such as Moodle, it is just a matter of clicking on the appropriate identification to confirm they attended or participated. A recipient is free to dispatch and make public the Open Badge to a Backpack or other platform such as LinkedIn.com. The setting up of these Backpacks is a quick process, at no cost to the recipient.

There could be an initial cost for the organisation in setting up the Open Badge scheme. Professionals can be employed to design and provide the code for the original badges, or they could be set up by say the lecturers themselves through a Virtual Learning Environment (VLE) such as Moodle [8]. The organisation can also register with an Open badge provider, such as Credly [9], Badgr [10] and Open Badge Factory [11]. There are several platforms where badges can be created and issued such as OpenBadges.me [12]

## **2.0 Experience at Southampton Solent University**

Open Badges have been used in a limited way for several years at Southampton Solent University, by one of the authors, Reid on various undergraduate courses.

Initial experimentation of Open Badges for recording and rewarding practical tasks on Content Creation Techniques MED400 took place over the academic year 2014-15, with Open Badges being awarded to students through the Moodle Virtual



Learning Environment (VLE) on completion of formative assessments tasks. Research undertaken by Glover and Latif [13] found that Open Badges were an extrinsic motivator that could offered value to less academic students in practical tasks not covered within summative assessment.

An important consideration to take before implementing an Open Badges awarding system is to first establish why a badge will be awarded [14]. As unlike digital badges, Open Badges contain Meta Data which is “baked” in and so cannot be changed or revoked. [15]

Within the badge structure a range of information can be saved from basic information to criteria and evidence that the badge has been legitimately awarded by “baking” in an Assertion which validates the badge (Figure 1) and its recipient this data supports the badges ability to be transported across various platforms [16].

The Content Creation Techniques unit’s summative assessment involved a group work project to produce a three-minute video and an associated podcast on a chosen topic within the theme of web or digital design. Classroom learning activities were focused on getting the students proficient in using both video and sound recording equipment, as well as developing a professional approach to working as a production team through undertaking several formative assessment tasks building both skills and confidence in three stages; beginner, intermediate and advanced.

A system was needed to both document and reward the completion of the formative tasks. It was decided to use the newly integrated Open Badges function within the VLE to implement recording all the formative tasks.

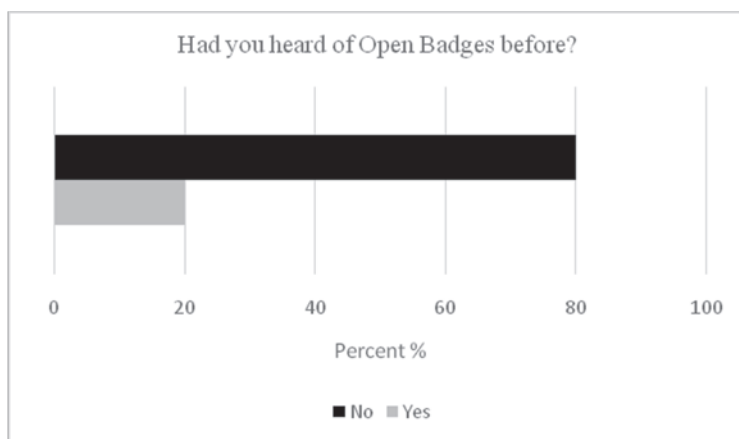
It is important to have an overall consistent design strategy for all the badges that are to be issued as once issued they cannot be changed. The badge designs were created in Adobe Photoshop and incorporate Creative Commons License Zero (CC0) [17] graphics before being saved as a Portable Network Graphics (PNG). As previously discussed, there are several online platforms that enable the design and production of digital and Open Badges.



**Figure 1:** Open Badge Designs for video tasks

Once the decisions were made on what criteria each the badges should be awarded for the set-up was straight forward. Firstly, badges need to be designed for each of the formative tasks which were broken down into three levels for each of the formative tasks (Figure 1). The designed Open Badges were then uploaded to the VLE using Moodle’s Badge set up activity. The uploaded badge is given a name, description, issuer contact details, expiry date, award criteria, links to evidence and set up of an awardee confirmation email template.

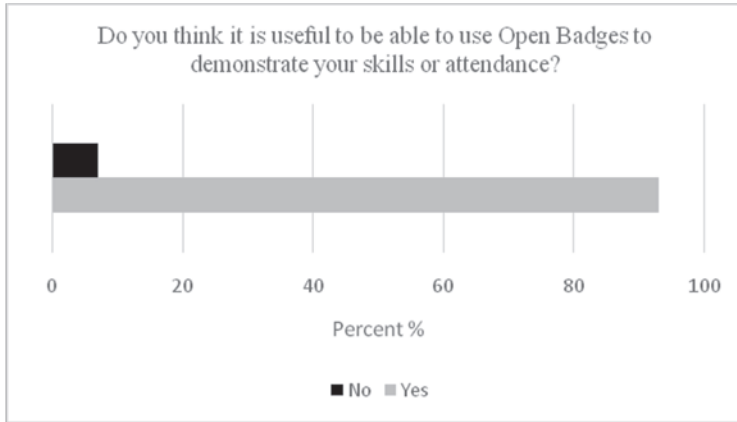
Badges were then issued either manually through the Award Badges Activity or automatically through Moodle’s Completion Tracking which allows badges to be awarded based upon the completion of defined activities such as quizzes and task engagement. [17]



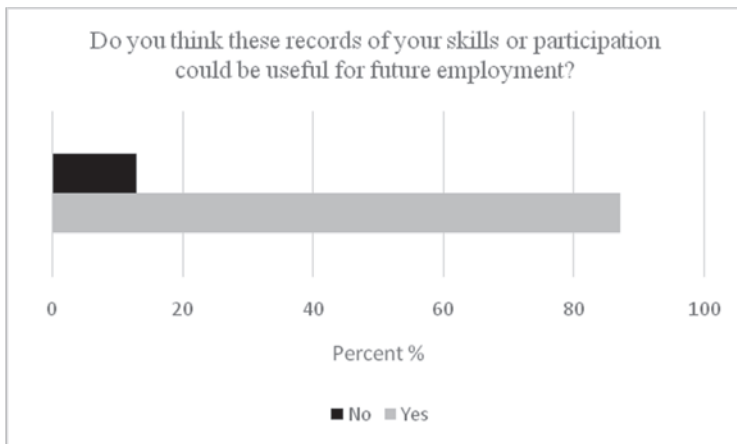
**Figure 2:** Students - *Had you heard of Open Badges before?*

## 2.1 Student Views

A survey and a focus group discussion were undertaken with a sample of 39 students that received Open Badges. Only 20% had heard of Open Badges (Figure 2). 93% thought issuing badges was a good idea to demonstrate the skills and engagement (Figure 3). 88% felt Open Badges would be useful to employability (Figure 4), although in discussion, some students had concerns about how valid their awarded badges would be outside an institution or community of interest and finally, 95% believed that wider use of Open Badges was a good idea across other units and courses (Figure 5).



**Figure 3:** Students- *Do you think it is useful to be able to use Open Badges to demonstrate your skills or attendance?*

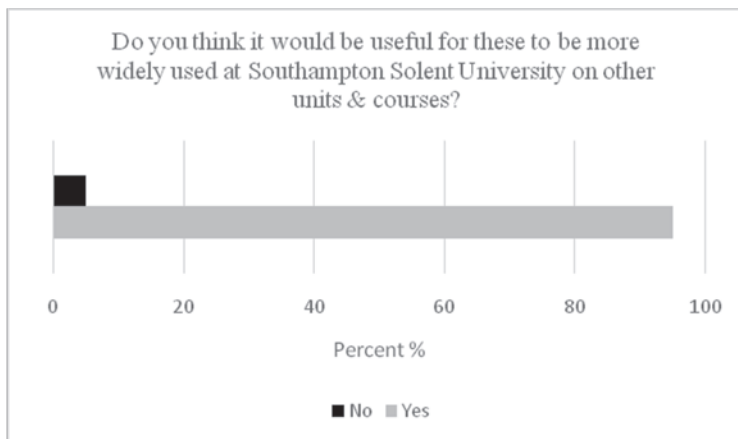


**Figure 4:** Students- *Do you think these records of your skills or participation could be useful for future employment?*

Based on positive student feedback and discussion, moving forward a more formal approach to awarding badges as many employers feel there is a disconnection between what is formally delivered in education and the skills that are needed in the workplace [19]

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**Figure 5:** Students - *Do you think it would be useful for these to be more widely used at Southampton Solent University on other units & courses?*

So, digital credentials awarded through Open Badges and shared, need to be meaningful, transparent and link to convincing evidence of achievement. There are several good examples of successful badge ecosystems such as badge awards on Stack Overflow for community involvement [20] and Khan Academy for skill acquisition [21] The Open University [22] and Deakin University on capstone units within their digital master's programme [23].

## 2.2. Views of Lecturers

Interviews were conducted with various computer lecturers, on courses ranging from technical to business orientated, at Southampton Solent University, to intensify their experience or knowledge of Open Badges. The actual or perceived advantages of using these; the actual or perceived problems and the potential actions to minimise these problems were ascertained.

The actual or perceived advantages were:

- Free equivalent of CPD
- Might encourage students to do extra tasks
- Encourage students to excel
- Plentiful opportunities to earn these badges might encourage students
- It could work if there was a perceived value of the badge
- Ability to show success and recognition of skills obtained by the students

The actual or perceived problems were:

- Students say they have not time for un-assessed tasks due to work commitments
- Lack of engagement from students
- Robust or reliable systems is essential to support the badges
- Students might not respect the value of them
- Promotion of the benefits of Open Badges would be needed
- Need to be widely used to give credibility
- Value not understood
- Open Badges could be over used
- Need clear standards for attainment of the Open Badge

Although none of the lecturers interviewed had had a prior experience with Open Badges, they were interested to hear about the current and potential use of Open Badges

### **3.0 Use of Open Badges for Organisations such as the BCS.**

Professional institutions, like the BCS, The Chartered Institute of IT, expect their members to engage in Continuous Professional Development (CPD). One means of recording participation in BCS activities could be by Open Badges, rather than the current means such as paper CPD forms or internet based.

The Open Badges could include the BCS logo, together with the appropriate Branch or Specialist Group identification.

Once established for a Membership Group, an Open Badge could be generated easily for each event, with the level of participation indicated using bronze, silver or gold surrounds to the badge. Attendees, whether in person or remotely, such as for webinars, could be informed about the use of these Open Badges in advance, and their e-mail details are sent to the organiser. The level of participation might be for webinars, attendance (bronze), as a panel speaker (silver) and as a webinar leader (gold). Similarly, for a Branch or Specialist Group meeting, this could involve a bronze badge for attending, a panel speaker receiving silver whereas the main speaker and Chair could receive a gold edged Open badge.

For events like a conference, again attending could result in bronze level badge, whether in person or remotely, presenting a paper with a silver badge, and a keynote or session chair perhaps a gold badge.

These badges could be easily, and more economically, produced and distributed compared to the current paper CPD forms. This is particularly relevant for events, where the attendees often fail to register in advance, so making plans for catering and producing the hard copy of CPD forms difficult. These badges could also encourage attendance at events.

## 4.0 Conclusions

The next stage at Southampton Solent University will be to develop more formal criteria for awarding Open Badges to all students across the Computer Programme. This will involve complete online quizzes that will automatically issue an Open Badge for study skills such as research, academic report writing and referencing, these badges will expire after a year and will need to be renewed.

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# A Facebook Group among Postgraduate Students: Evaluation Results towards Learning

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## Abstract

Facebook is a very popular social media platform used by a significant number worldwide. There is strong evidence that Facebook may also facilitate learning activities, however there is not much research about the implementation of Facebook as a learning tool in higher education. In this study the authors investigate the use of a Facebook group among postgraduate students at the department of Informatics of the Technological Educational Institute of Thessaloniki, Greece. In particular, the contribution of a Facebook group regarding four factors is measured: students' engagement, students' motivation, students' collaborative learning and students' satisfaction. Furthermore, any significant correlations between the variables are carefully examined. This study shows that a Facebook group is able to facilitate learning among students in a positive way and consequently work fairly as a collaborative learning tool.

**Keywords:** Social networking; Higher Education; Facebook group; Collaborative Learning

## 1.0 Introduction

Collaborative Learning (CL) is the process of learning which is not gained individually but includes discussion, argumentation and reflection. Collaborative Learning Environments are opposed to individual environments, since they lead to a better processing of the information upon a task having an important effect on learning [1]. Collaborative Learning may be a great way of structuring activities in a learning environment in a sophisticated manner. This environment may be formed desirably of specific elements, which are intended to bring a deep and

complete learning capability to the participants.

Human learning and development are strongly affected by social content. There is a view of [2] arguing that learning is an individual process in which a person can be benefited or not, according to the interaction with each other. Therefore, improvement can be obtained via communication of the problem among the participants, which can positively affect reflection and planning. Computer Assisted Collaborative Learning (CACL) provides an appropriate environment for enhancing students' learning processes via collaboration with the use of Computer Mediated Communication (CMC). In a CACL environment, students can use the provided tools, in order to communicate, share information and expertise [3]. Additionally, there is a different amount of contribution among the students' which is based in the type of their motivation.

The concept of motivation can explain the reason of different levels in a student's contribution in CACL. Motivation is an important factor that influences one's learning attitude and behaviour [4]. As motivation means to be moved to do something, it can be used as the degree of self-determination of learners [5]. A person can have little or a lot of motivation [6], also referred as a-motivation versus motivation, with a-motivation expressing the lack of intention to act. However, the effort of someone to pursue a goal cannot be expressed only by the amount of motivation, but also from the type of the motivation. The Self-Determination Theory (STD) describes the type of motivation according to its origin; the theory targets the types, rather than just amount, of motivation, focusing to autonomous motivation, controlled motivation, and a-motivation as predictors of performance, relational, and well-being outcomes [7]. Therefore, it can be a distinction of motivation in extrinsic and intrinsic [8].

Social networking sites are able to increase the engagement of the students in an online learning community as they offer a technology which is well-known among their generation [9]. Facebook is one of the most popular social platform worldwide [10] allowing users to interact and collaborate in a sophisticated manner. Even though Facebook has started as a great place for social networking activity, it soon reached the potential of facilitating students as an e-learning tool [11].

University education is fairly collaborative oriented and promotes group work in many circumstances, therefore, an online tool such as Facebook and Facebook group in particular, is of a great importance. The aim of this study was to evaluate the amount of Facebook group's efficiency among postgraduate students. In addition, the authors also examined any significant correlations between the variables according to the hypothesis that a student with a greater degree of engagement would have bigger learning benefits.

## 2.0 Methodology

The students that participated in this study are members of a Facebook group which has been created to support them in their postgraduate studies in Computer Science. The title of their MSc is Web Intelligence, and the use of the group was for all modules in the 2 year MSc course. The Facebook group was created and managed by the students and was being used exclusively by them.

The study was conducted between two different Facebook groups from the same postgraduate program and for two different entry years; namely entry in autumn 2013, hereafter called group2014 and entry in autumn 2014, hereafter called group2015.

The number of the students that is considered for this study is 21 for each group. The group2014 consisted of students aged between 25-40 years, 6 females, with most of the students being experienced Facebook users. The group2015 had students aged from 20 to 45 years old, 3 females; and most of the students had medium Facebook experience.

Both of the Facebook groups (group2014 and group2015) were used to facilitate the students' learning experience as well as to promote their communication and interaction in an online environment outside the classroom. The program of their studies includes compulsory attendance of ten modules in the first two semesters with each semester has five modules of 6 ECTS each module and a third semester include the completion of their diploma thesis. The student's in order to succeed in each module they should have achieved a specific score in several essays and exams of each module; in most of the essays the teamwork was characterised essential by the tutors.

In this study the authors investigate the Facebook group as a tool for collaborative learning in the first two semesters of their studies, where the students were actively involved in group work and the use of Facebook through exchange of posts and messages, which was considered unquestionably helpful by the students.

Each student that participates in this survey had to contribute in a five scale questionnaire after the completion of his/her modules of compulsory attendance. The questions were conducted in groups in order to support and evaluate four different constructs: students' engagement in the Facebook group, students' motivation via the Facebook group, students' collaborative learning via Facebook group and students' satisfaction about their overall experience in the Facebook group. These constructs will be briefly referred as: students' engagement, students' motivation, students' collaborative learning and students' satisfaction.

To evaluate the study the authors define each of the constructs by three parameters (table 1 and table 2) which were being rated from the participants. Each answer for these parameters was having a value from 0 to 1 with step 0.25 or from 0.2 to 1

with step 0.2 in respect to its scale. For example, if a participant answered a question which the answer was not contributing at all to support the question namely “not at all“ would take the value 0 and all the other answers of this question would take from 0.25 to 1, having of course the most “agreeable” answer taking the value 1. However, there are some questions that do not consist of this kind of negative answers as their starting point, for example where the question was “How often would you visit the Facebook group?” there was not such a starting answer as “never” but “more than every other day” having the 0.2 value and the answer “more than five times a day” with 1 value.

Table 1. The parameters of students’ engagement and students’ motivation

<b>Students’ Engagement (Engagement)</b>	<b>Students’ Motivation (Motivation)</b>
(1) The number of hours spent weekly in the Facebook group.	(1) The degree of team spirit within the group.
(2) The rate of visiting frequency at the group.	(2) The degree of communication flexibility via the group.
(3) The type of the members’ activity within the group.	(3) The degree of knowledge exchange within the group.

Table 2. The parameters of students’ collaborative learning and satisfaction

<b>Students’ Collaborative Learning (Collaborative Learning)</b>	<b>Students’ Satisfaction (Satisfaction)</b>
(1) The degree of effective advising among the members of the group.	(1) The degree of the group’s importance for the students’ studies.
(2) The degree of timely responses from the members of the group.	(2) The degree of the students’ contribution to the students’ learning process.
(3) The degree of problem solving deriving from the group members.	(3) The type of the overall experience from the participation in the group.

For every participant a score has been calculated for each of the four constructs of this study according to his/her answers to the question that contributed to each parameter of the construct. For example, as far as students’ engagement is concerned, if a student’s answers to the questions that contribute to each parameter have the values 0.2, 0.4 and 1 respectively the score of this student would be 0.54 [  $(0.2+0.4+1) / 3$  ]; which score is defined as 54% support for the student’s engagement.

### 3.0 Results

For each group the authors calculated the average score of their students regarding to the four constructs as described above. The results are shown in the table 3 as well as in figure 1.

Table 3. The percentage of the students average score for each construct

	Group 2014	Group 2015
Engagement	54%	41%
Motivation	63%	67%
Collaborative learning	69%	61%
Satisfaction	59%	58%

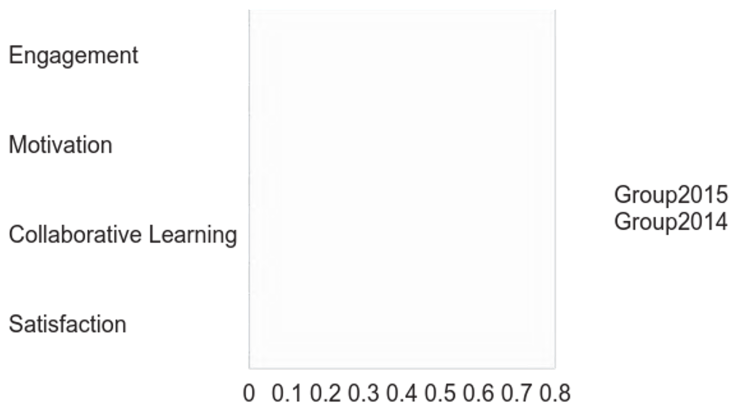


Figure 1. The average score of the students for each construct

For each member of the group the authors consider his/her scores for the four constructs of the study, in order to find any correlations between the constructs defined according to Pearson's theory [12]. They chose to analyse the data using Pearson's correlation since most of the examined variables are according to the required criteria of this method. Namely, the variables are continuous, have a linear

relationship between them and are normally distributed.

More specifically the authors investigated whether there is a correlation between: students' engagement with students' motivation, students' engagement and collaborative learning and students' engagement along with students' satisfaction. The authors completed this investigation for the data of both of the groups respectively.

In order to succeed in these correlations the authors conducted the Bivariate Correlation Analysis (2-tailed) in SPSS to calculate coefficients ( $r$ ) having measured the significant level of these correlations by  $p$ -value. The smaller the  $p$ -value is the more significant the relationship is described, and the bigger the ( $r$ ) value is the more strong the relationship is found. For a larger scale studies attention is given more at the  $r$ , and for small scale studies at the  $p$ .

The results of the correlations for both groups as shown in table 4 indicate that a discussion should be made about the first and the last correlation pair, since the correlation between students' engagement and students' collaborative learning does not imply for making any conclusions since the value for group2014 is low.

Table 4. Correlations between the examined variables

	Correlation between Engagement and Motivation		Correlation between Engagement and Collaborative Learning		Correlation between Engagement and Satisfaction	
	$r$	$p$	$r$	$p$	$r$	$p$
<i>Group2014</i>	0.443	0.044	0.283	0.214	0.615	0.003
<i>Group2015</i>	0.494	0.023	0.507	0.019	0.605	0.004

The correlation between the students' engagement and students' motivation is of medium degree for both of the groups with ( $r$  0.443,  $p$  <0.044) for group2014 and ( $r$  0.494,  $p$  <0.023) for group2015; according to the ( $r$ ) value the relationship of students' engagement and students' motivation is not weak, and therefore a change on the value (increase) in students' engagement would probably affect the value of the students' motivation. Moreover,  $p$ -value indicates that there is also a statistically significant correlation between these two variables, which means that increases or decreases in one variable are significantly related to increases or decreases in the other variable.

The correlation between the students' engagement and students' satisfaction is fairly high in both of the groups with group2014 to have ( $r$  0,615,  $p$  <0.003) and group2015 having values ( $r$  0,605,  $p$  <0.004). The results indicate that this is the most correlated pair of the study, since it has the highest ( $r$ ) value in both of the

groups and this leads to a conclusion that this pair has the strongest relationship among the investigated variables. Subsequently, the p-value in this pair is the lowest among the observed p-values and this indicates that the relationship between these variables has the highest statistical significance among all observations.

## 4.0 Conclusion

This paper has described the benefits of using social networking tools, such as Facebook group, in an academic environment. This research indicates that a Facebook group is an important tool for enhancing students' learning and can support fairly the collaboration between them. Furthermore, it is approved that there is a correlation between the students' engagement to the group and their learning benefits and that someone can have better learning benefits when he/she is more engaged to the group. Even though the study was closely conducted among the students and the use the group was dominant during the students' first study year, the authors recommend a similar research in a bigger number of participants for better evaluation.

## 5.0 Acknowledgements

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# Encouraging Re-Employability and Discouraging Bias

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## Abstract

The paper discusses the need for more IT professionals and the need to retain those taking career breaks. The paper discusses the current situation in the UK for unemployed and under-employed computing professionals; and the view of professionals about the need for regular updating of their skills, particularly if they are currently unemployed. The needs of those taking an extended career break, of say five years are also discussed, together with help to encourage and assist those returning to the computing industry.

The paper discusses the actions that have been undertaken by the BCS Quality Specialist Group, BCS Women and Hampshire Branch to provide free training courses, together with the BCS Unconscious Bias Training for all BCS committee members. The comments of those attending these various BCS training courses are discussed.

**Keywords:** Under-employed, re-employability, extended career breaks, BCS, Unconscious Bias

## 1.0 Introduction

Computer professionals have by choice or otherwise sometimes taken a career break of possibly five years or more, in some cases to care for very young children. In recent years, due to a number of reasons including the financial crisis and instability, projects have been cancelled or postponed. As a result many experienced IT professionals have become either unemployed or under-employed, as consultants, contractors or those previously in full-time employment. It takes time to obtain a suitable position. This can result in both financial and emotional strain. Also in the fast-changing IT profession their skills can become less current.

In addition, these professionals were probably used to working with other professionals, so might be missing the technical networking aspect of their previous roles [1, 2], as well as the social contact with long term colleagues.

The predicted increase in the need for IT professionals, particularly in Western countries is widely recognised [3]. It was reported that “the UK will need 745,000 additional workers with digital skills to meet rising demand from employers between 2013 and 2017” [4, 5]. There is a need to encourage "returners", both male and female, to the IT profession. It was reported that those shortages in the computing industry also apply to other science, engineering and technology fields [6].

## **2.0 Actions to Address Extended Career Breaks**

Various large organisations have realised the advantages, including financial, of maintaining contacts with experienced IT professionals on extended career breaks of say five years or more, with the aim to re-employ them later. The advantages of those with prior experience and loyalty to the organisation, cannot be underestimated. Companies, such as IBM, introduced a "buddy system". An example of this could be if a woman or man, plans to take an extended "parental leave" until the child starts school, the employee could be paired with another as a "buddy/mentor" who had undertaken earlier a similar extended career break then returned to the organisation. By encouraging regular contact with their "buddy/mentor", the one on extended parental leave could be included in social events to maintain the internal networking and also at very low-cost, training courses, so maintaining their technical skills up-to-date.

There is always the risk that the person will either decide not to return to the computing industry or to join another organisation. The advantage of persuading at least some of the potential returners to re-join the organisation could outweigh the low cost and risks, especially as the "re-joiner" could be very quickly assimilated into the organisation with current relevant skills and with an enhanced loyalty to the organisation.

### **2.1 Actions by the BCS, The Chartered Institute of IT**

Various BCS Branches, Specialist Groups and International Section events have been organised to enhance and maintain the skills of employed and those currently not working in the IT industry. These events include webinars, visits to companies, workshops, presentations and courses, as well international conferences. Additionally, online discussion groups provide useful networking opportunities.

## 2.2 BCSWomen Specialist Group

The BCSWomen Specialist Group [7] has, for many years, been providing support with CVs, mentoring and networking opportunities. Examples of these are speed networking sessions, and the training in the use of Android devices, use of Open Source software and introduction to Artificial Intelligence. These are either free or are offered at a very low cost. These courses are particularly useful for those on extended career breaks. Many of the participants feel that their skills might require updating before they re-enter the computing industry.

There is a need to encourage returners to the industry, as well as potential computer professionals of the future. The percentage of women in the UK computing industry is 17% which is the same as the average of the other EU countries, which range from 11% in Luxemburg, to the 32% in Bulgaria [3, 8]. This indicates there is an opportunity to increase the number working in IT by encouraging girls to consider IT as a career. The BCSWomen Specialist Group organise events to encourage women and girls into computing. The members also produced posters, showing the roles of actual women in computing. In addition the BCS produced a free e-book, Women in IT, Inspiring the Next Generations, [9] with the backgrounds and career progression of thirty women, mainly in industry, as potential role models.

## 2.3 BCS Quality Specialist Group

A series of one, two and three full day courses run by Tom Gilb Hon FBCS have been organised by the BCS Quality Specialist Group [10]. The above courses were free for BCS members and either free or under £50 for non-members.

Initially these had been aimed mainly at the "under-employed" IT professionals. The attendees had been a mixture of unemployed and those consultants and contractors that were unable to obtain their normal quantity of employment. Some attendees were in employment, particularly from smaller organisations, which were unable to offer training opportunities due mainly to the cost. The courses held included:

- Advanced Project Management : for Quality and Rapid Value Delivery (2 day courses)
- Project and System Level Requirements Specification (2 day courses)
- Lean Quality Assurance (2 day and 3 day courses)
- Real Architect Course (1 day course)
- Requirements Engineering (2 day course)
- Architecture Engineering Tools, a quantified multidimensional approach to IT architecture and design (2 day course)
- Specification on Quality Control Engineering (1 day course)
- Value Delivery Management Tools (1 day course)

These courses have been mainly held in London, but also in the Midlands and in Scotland. They have been open to both BCS members as well as non-BCS

members. The feedback from these courses has been amazing, with quotes from attendees such as:

- “Thank you for making this a free course, as a job seeker, it is extremely difficult to near not possible to fund myself on formal training courses”.
- “I was able to use these considerations at a recent interview & of course will be using the techniques on my next project.”
- “May I just say that I found the two days very worthwhile and appreciated the time and effort that Tom has clearly put in to prepare to cover these important topics. Tying projects and their value back to the business, business priorities and financial benefits would appear to be fundamental ... and yes it is often overlooked by the lack of breadth of many project managers and their project sponsors”.
- “You have allowed me to see I DO know how to do my job; I have been able to restore my confidence in myself”

## **2.4 Branch Activities**

A number of free one day courses have been held by BCS Hampshire Branch [11] which were available to both the BCS and non--BCS Members. Again the preference was given to the "under employed". These have been laboratory based, where up to twenty attendees have been able to increase their skills on courses such as Web Development (1-day course), or on the soft skills which have been run in a classroom environment. The Soft Skills course was aimed in addition at the recent IT graduates as well as the under-employed experienced professionals. Although many of the latter group had been able to obtain Government backed assistance with CVs, and interview skills, these are not necessarily related to current IT practices. In many cases it has been a considerable number of years since those professionals had applied for a job. The new graduates are in a different position, having, through their courses, currency in technical ideas but often they have had little or no experience of genuine job interviews in the computer industry.

It has been reported by those attending that both these technical and non-technical courses have been of considerable interest and benefit to the attendees. The positive views from the attendees of these Hampshire Branch courses, as with those that attended the Quality Specialist Group courses, reflect the benefits experienced, both from the technical knowledge but also from addressing the issues of isolation felt by those professionals after being under-employed for several months or several years. The advantages of being able to network with other computer professionals in similar situations have been reported to be of direct benefit. In a few cases, new start-up companies have been formed between professionals with similar or complementary skills, having met on these courses. Evening sessions also have been held by the Hampshire Branch at Southampton Solent University, with specialists about the assistance available for micro SMEs, with fewer than ten employees, information on forming a company, the legal and financial actions required, advice on low-cost internet marketing, including the benefits of Search Engine Optimisation to raise the profile of their websites.

A series of presentations was also arranged to assist in coping with redundancy, considering both the legal issues and the emotional ones. An attendee of one of these sessions e-mailed to say that "it was unfortunately so relevant, as I was made redundant unexpectedly the following day".

### 3. Results of Survey of Course Attendees

The survey was undertaken of a sample of 176 attendees of the full-day courses by Tom Gilb Hon FBCS, to identify their background, needs and views. Of the course attendees, 54% were already BCS members, while 24% said that they were now thinking of joining. Eighty eight per cent were thirty years of age or older and 79% had worked in the computing industry for more than five years. Also 38% of the attendees were currently unemployed.

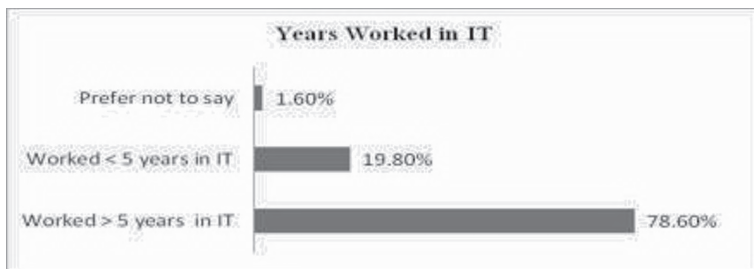


Figure 1: Length of Time Working in the Computing Industry

When considering the last year of their employment, whether currently employed or otherwise, 46% said they were able to attend at least one day's technical course in that last year and 47% said they were able to attend at least one day of non-technical courses during that final year of employment.

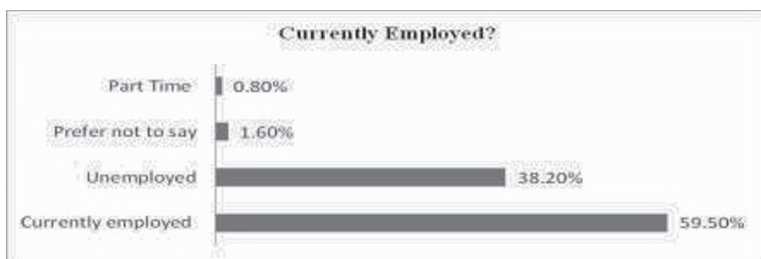


Figure 2: Current Employment Status

Regarding the attendance at a BCS events, 40% had previously attended a free BCS Quality SG full-day course, whereas 60% in the last year, regardless of employment, had attended a BCS evening event and 37% indicated they had

attended up to five evening events. Further Continuous Professional Development (CPD) activity was also undertaken by 55% of the attendees, these ranged from reading articles, attending conferences, attending trade shows and participating in webinars.

The respondents of the survey were asked to identify the major advantages and disadvantages of regular courses or CPD activities.

The advantages of undertaking CDP were stated as follows:

- Improvement of Knowledge and Skills
- Keeping Up-to-date
- Networking
- Being Professional
- Improvement of Job Opportunities

These were similar to the results of the advantages of undertaking these courses, as shown in Figure 3.



Figure 3: Advantages of these Courses

On comparing the views of those in employment and currently not in employment with the disadvantages of attending courses and undertaking other CPD activities, the majority of those in employment identified disadvantages of "Time" as a major issue, whereas "Cost" such as of travel, was the major disadvantage for those currently not in employment. The combined results of the disadvantages of undertaking these courses are shown in Figure 4.



Figure 4: Disadvantages of Attending Courses

The respondents were also asked to indicate topics on which they would like to attend courses. In general, the topics suggested by thirty of those in work were mainly on specific technical topics, such as Agile, mobile computing, Six Sigma, Big Data, Project Management, Testing, more from Tom Gilb Courses and popular programming languages. However one liked "starting a business" and "practical



## 5.0 Discouraging Un-Conscious Bias

Surveys [6, 12, 13] were undertaken, including by the Royal Academy of Engineering, on different aspects of diversity. It was found that between 12% and 15% of engineering students were female, but only a slight difference existed in the ability of the proportion of the students to gain employment in the engineering and technology sector, favouring male students (56%), whereas slightly a higher proportion (51%) of the female students undertook further study. The variation regardless of gender, indicated a larger difference between ethnic backgrounds. It was found that 71% of the "white engineering graduates" compared with 51% of the BME (Black and Minority Ethnic) graduates were in full-time employment within six months of graduation. After six months, 60% of the white students whereas only 40% of the BME engineering students had employment in "Engineering occupations, with 14% of the black engineering graduates unemployed compared with only 7% of the white engineering graduates".

Action should be undertaken by BCS Branches, Specialist Groups and International Sections to avoid Unconscious Bias. The survey was undertaken by the Employers' Network for Equality and Inclusion [13], showed that of those surveyed:

- 34.1% had a bias in favour of non-disabled people over disabled people
- 16% had a bias in favour of white people over black people
- 2.6% had a bias in favour of men over women
- 67% of the British public feel uncomfortable talking to people with disability
- 36% believe disabled people are not as productive as everybody else.

The unconscious bias could relate to any form of bias, from disability, ethnical, religion, sexual, gender, being too old or too young. Equality and diversity is viewed as of utmost importance for many years to the BCS. Although to date only one metric has been set by the BCS Trustee Board. This is that all BCS Boards, Committees etc should aim for 20% of women which should eventually progress to 40%. Other metrics relating to different aspects of inclusion were considered, but these would be more sensitive to collect. The BCS specified that all BCS volunteers who serve on Committees, Boards, Council and the Trustee Board, should undertake the BCS Unconscious Bias training session, lasting about one hour.

There is normally very positive response to those that have attended these Un-Conscious Bias sessions. A few of the views include:

- "Engaging. Will have things to take back to the branch to consider on future undertakings"
- "Recommend a wider range of members being trained on this topic - for example, software programmers would benefit from considering these issues in product creation"



- "Very useful. Has given me a lot to think about regarding developments that my Branch, decisions that my Branch has made in the past and better insight into what we could introduce going forward"
- "Glad to have done it. I liked the open discussion format"
- "Highly beneficial and very useful. Exercises were very good, diversity across the group was very beneficial"
- "Thought provoking scenarios, useful discussions".

These sessions should raise awareness of issues such as trying to ensure that any disabled attendees can have suitable access to the locations and facilities, although this is not always possible, such as in the case of visits; requesting a speaker to face an attendee who is known to have to lip-read. Other issues if known about in advance, should be considered and if possible solutions or ways to minimise the various problems, associated with sight, such as requesting speakers to use suitably larger font for power point slides, or not using colours such as red against a green background. Issues relating to arranging for special diets and separation, or labelling of refreshments should be addressed whenever possible.

As part of the planning of the BCS programme, attempts could be made to include a variety of speakers such as from different ethnic backgrounds and gender. To try to help to address the problem experienced by many disabled new computing graduates, in obtaining their first employment in the IT industry, events could be organised, such as those held by the Hampshire Branch. These were aimed at encouraging organisations to consider employing IT professionals with disabilities. A panel was formed to include a wheelchair user, a blind and a partially sighted IT professional, together with their direct managers, to discuss any issues and how these were overcome.

## **6.0 Conclusion**

It is hoped that by these various initiatives taken by the BCS, or by other organisations will encourage more people to enter or re-enter the computing industry. The BCS Taking a Break, A Career Break Planning Guide for People in the IT Industry [14] gives detailed check lists and advice before and after taking a career break, including the warning that it is more difficult to return to work if the career break last over two years. It also gives practical advice on maintaining an active CV during a career break, including undertaking related and non-related voluntary work, attending free or distance learning computing training courses and writing article. Suitable role models, such as those shown in the free e-Book, "Women in IT" [9] produced by the BCS, and activities to encourage self-confidence and to up-skill professionals might hopefully help to address these issues, and overcome problems of unconscious bias.

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