INSPIRE XXIV

Global Connectivity and Learning across the Generations

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on
Global Connectivity
and
Learning across the Generations

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PREFACE

This volume contains the edited proceedings of the twenty fourth International Conference on Software Process Improvement Research, Education and Training, INSPIRE 2019 held at Solent University, Southampton, 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 2019 has attracted papers from international sources, covering a broad spectrum of practical experience and research. The topic areas include computational thinking, use of gaming in education, student engagement and employability, MOOCs, and lifelong learning.

We would like to thank the many people who have brought this twenty fourth 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 the BCS and Solent University for their sponsorship.

The Editors

CONTENTS

Keynotes

How will the Fourth Industrial Revolution Impact Education?
Professor Liz Bacon (Vice-Principal and Deputy Vice-Chancellor (Academic), Abertay University) ***11***

Teaching useful knowledge: Some principles of Useful Knowledge, and Some Classical Ideas about Undergraduate Basics
Tom Gilb Hon FBCS ***21***

Papers

MOOCs, SPOCs and Other Platforms: A Journey into Online Teacher CPD
Amy Icke, (The Girl's Day School Trust) ***31***

Can Work-related Learning Activities Improve Student Engagement in Higher Education?
Paul Albinson, (Bournemouth University) ***43***

Teaching Computational Thinking via Tangible and Graphical Interfaces – An Overview Through Reflective and Critical Lenses
Technologies and Services, Tampere and Cubes Coding, Consumer Electronics, Tampere, Finland), Eleni Berki (*University of Jyväskylä, Finland),* Juri-Petri Valtanen (*Tampere University, Finland),* Theodosios Sapounidis (*Aristotle University of Thessaloniki, Greece and Cubes Coding, Consumer Electronics, Corp. Headquarters, Thessaloniki, Greece)* ***55***

The Perceptions of Technology for Education, A Generation-Z Case Study
Eleanor Dewar (Ocelot Educational Research and HAVRE) **69**

The Cultural Impact of Accessible Gaming Mechanics: A Study Comparing Nepalese and UK Computing Students
Carole Morrell, Mandy Morrell, (University of Northampton) **81**

Creating a syllabus for Cyber Security Careers and Employability
Peter Komisarczuk (Royal Holloway University of London) **93**

Digital Learning Challenges and Innovations for Sustainable Education in Developing Countries: Issues of Policy and Practice
Linda Odhiambo Hooper, James Uhomoibhi (University of Ulster) **103**

Digital Game-based Learning in Education: Significance of Motivating, Engaging and Interactive Learning Environments
Georgios Lampropoulos, Theofylaktos, Anastasiadis, Kerstin Siakas (Alexander Technological Educational Institute of Thessaloniki, Greece) **117**

Making Sense of Digital Content Strategy, Higher Education and Student Recruitment
Oksana Razina, Mohammed Al-husban, Shakeel Ahmad, Margaret Ross (Solent University) **129**

The Five Stage Framework for Life Long Learning in Engineering Education and Practice
James Uhomoibhi *(University of Ulster),* Margaret Ross *(Solent University)* **143**

Keynote 1

How will the Fourth Industrial Revolution Impact Education?

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Abstract

This article examines the implications of the 4th industrial revolution on education. It discusses how technology has / has not impacted traditional approaches to teaching and the reasons why this is the case, and the drivers and motivation for change from both an individual and institutional perspective. The current uses of artificial intelligence in education are discussed alongside a discussion regarding potential future educational models, and the associated ethical, security and privacy issues. The paper concludes with a discussion about what this could mean for universities going forward as they progress towards a personalised mass education system.

Keywords: 4IR, Artificial Intelligence, Education, Learning

1.0 Introduction

Many would argue that education is about to undergo a revolution [1], however if you look inside a typical classroom at university today, for the most part little has changed for decades in the way students are taught, other than some additional use of technology which is typically used to support traditional teaching models. In most disciplines, lectures remain the core approach to educate students [2], typically being followed by seminars, tutorials and / or laboratory sessions etc. as appropriate. In terms of technology, virtual learning environments (VLE) have become a sector norm but the typical use for these is as material repositories, coupled with perhaps a discussion forum and / or one or more online quizzes. Of course many academics using technology to innovative pedagogy in the classroom e.g. flipped learning, however this is not currently the norm.

Just because technology enables us to teach differently, that doesn't mean we should. Pedagogy should always be the driver for change, with technology being the enabler if appropriate. However, teachers should regularly reflect on the benefits and appropriateness of changing their approach to teaching, given traditional approaches have worked for a very long time and do have their benefits, for example, lectures are efficient. Lectures do of course have their downside for example it is recognised

that students may go in to cognitive overload trying to understand and absorb so many concepts in such a short space of time, resulting in them missing information if a lecture is not recorded for review [3]. In addition, many academics may be cautious about experimenting with new approaches to teaching and learning for a variety reasons e.g. the effort required to change and fear of failure. Finally, considering the classic saying in relation to lectures "Tell me and I forget, teach me and I may remember, involve me and I learn", the precise wording of which varies and source of which seems to be debated [4], but would appear to be a generally accepted truth that most educators recognise. Lectures tend to be passive experiences and as such are unlikely to embed deep learning during a lecture session. One reason lectures may have survived until now is that it may be an efficient way of ensuring students have the knowledge to then be able to undertake some practical where the learning is more deeply embedded through engaging in a practical activity of some sort.

Technology has now provided us with more choice about our education is delivered and students with more choice about how they learn. However, a key notable difference is that technology allows us to move away from a one-size-fits all to a personalised, individual experience which can scale to mass education. Personalised learning experiences vary in sophistication and can be interpreted in a variety of ways, from choosing the colour and layout of a user interface, to having a personalised digital assistant to support a student's learning, undertaking tasks such as: reminding students about upcoming assessment submissions, researching a topic and even vetting an essay draft. These activities raise the inevitable questions about where a line is drawn between proof-reading services and plagiarism [5] although in future students may be held to account for plagiarising their digital assistant's ideas and suggestions.

The rest of the paper outlines the current uses of AI in Education and reflects on educational models of the future, the direction of travel in terms of technology use and impact in education, including biohacking. The paper then reflects on some of the ethical and privacy issues of using AI in education, before drawing conclusions about the future.

2.0 Current uses of AI in Education

For as long as new technology has existed, people have predicted that it would revolutionise education however, as articulated by Derek Muller, [6] who reflected on a variety of technologies predicted to do just this over the last century e.g. radio, TV, computers and videodiscs, noting that none delivered on the expectation. It would therefore be quite right to ask the question about what might be different about the use of AI and other leading edge technologies in education, this time. Is it once again just hype? With regard to the future role of a university, almost everything someone may want to learn is on the internet somewhere, universities have to think very hard about their value add. Independent certification of learning is still

important so that is certainly one role but in terms of teaching, that may be less clear however, Muller argues that it is not the technology which matters, it's how it is used "to promote meaningful thought processes". In other words, the role of a teacher is to inspire, guide the process of learning, challenge their students, excite them to want to learn, make every student feel they are important and feel accountable for doing the work of learning, and help them filter the mass of educational materials readily available for students to use in their learning. However, as Derek Muller points out [6], the key to learning is not the technology but what is what is happening inside the learner's head. A key point which Muller makes is that it is important to make a learner think in order to learn and "making a learner think is best achieved in a social environment" with other learners and a caring teacher.

AI has not yet replaced teachers and it's unclear if it ever will however AI and smart technology are starting to deliver some of the expectations from the past. Below provides some examples of current technologies involving AI which are beginning to impact the education sector:

1. Smart campuses – there is no one accepted definition [7] but broadly these focus on technology infrastructure and providing sensors across a campus with applications related to movement, heat, CO2 emissions, energy monitoring, campus navigation, for example an application which provides information to students on the locations of a free study space. However, the applications tend to come in the form of siloed datasets.
2. Intelligent campuses – these are different to a smart campus in that they aggregate data [8] and analyse it to provide an insight into the student and staff experience providing information, for example, on the environment, library access, when the cafeteria is getting low on someone's favourite lunch special etc.
3. There are a range of uses of AI within teaching, these include: automatic marking of essays, [9], automated feedback including analysis of text in essays, personalised learning assistants which help to guide students through a variety of learning pathways depending on their needs, personalise text messaging, help with team formation etc. Technology is also starting to support students in drafting essays and in some situations has already become quite sophisticated outside of education for example, as reported in the New York Times, where "Roughly a third of the content published by Bloomberg News uses some form of automated technology" [10]. It does this by dissecting a financial report the moment it appears and then generates an immediate news story that includes the most pertinent facts and figures and of course it can do that 24/7 with no breaks or complaints.
4. Educational digital assistants - often based on IBM Watson's technology [11]. For example, Jill Watson was first used with a class on knowledge-based AI in the Spring of 2016. Jill had the ability to answer routine questions sufficiently well that many students could not distinguish Jill's responses from that of a human. The same technology has also been used by Deakin University, Australia, to develop its Genie app [12] which provides a personalised digital

assistant, that tries to bridge the gap between people and digital technology. Discussion is in natural language and aims to provide a digital companion to students which keeps learning over time.

5. Learning analytics – Prinsloo and Slade [13] argue that institutions have a moral obligation to act based on the data collected about students, however this should be tempered with appropriate ethical and privacy considerations.

3.0 Educational Models of the Future

Looking further into the future, there are a lot of predictions about the impact of AI, and whether it will be possible to automate all jobs eventually. AI is often categorised into a variety of types, the following being a common set of categories [14]:

- Narrow AI – this is AI which is very good at one task e.g. playing a game of chess, but collapses the moment it has to deal with information outside of its sphere of knowledge.
- General AI – this is AI generally considered to be at the level of human intelligence.
- Super AI – this is AI which is more intelligent than humans.

The future of AI is unclear other than it will at least for the foreseeable, deliver increasing levels of intelligence. Whether AI remains within narrow domains or whether these can be joined in some way to provide more sophisticated levels of intelligence remains to be seen. Looking to the future, many experts are predicting doomsday scenarios, for example the late Stephen Hawking [15] believed AI may replace humans and said "I believe there is no deep difference between what can be achieved by a biological brain and what can be achieved by a computer. It therefore follows that computers can, in theory, emulate human intelligence – and exceed it". He is not alone in thinking this however the concern is not just about the increasing intelligence of AI. A key area of research is around the modification of, and interaction of machines embedded within the human body, one of the reasons being to aid learning but there are many more. Elon Musk is quoted as saying "Over time I think we will probably see a closer merger of biological intelligence and digital intelligence" and that "People Should Merge With Machines" [16]. We already augment and monitor the human body in a number of ways e.g. use of fingerprinting, biometric monitoring, fitness trackers, heart monitors, eye trackers etc. however some technologies go considerably further, for example the area of biohacking where people will put technology in their bodies to experience different sensations or to make it perform better. De Beer and Jain [17] suggest there are 4 main categories of biohacking: research, play/hobby, outreach, and education and those who undertake extreme modifications are often referred to as "grinders" [18].

In addition to biohacking more futuristic mechanisms for learning are being explored, for example DARPA are not alone in investigating the possibility of uploading skills directly into the brain [19]. Whilst this is in the early stages, there are signs this could be possible in the future. In one way this could be appealing as

it could save humans many hours of effort learning the traditional way, however it raises many ethical issues. For example, how would that learning be verified? how would we ensure the learning hadn't been tampered with to cause harm? if we downloaded learning, would we all think alike? what would be the impact on those who didn't want to download learning, would they be less employable wanting to learn the traditional way? A key issue in the use of AI in education is who authenticates the learning given the potential for biased datasets, deliberate misuse, the prospect of brainwashing etc. AI is only as good as the datasets it has trained on and robust testing mechanisms need to be available to verify the use of an AI.

4.0 Ethical, Privacy and Security Issues related to the use of AI in Education

AI brings with it a huge number of unintended consequences. Like all technology, it has the potential for huge benefit but also the potential for both intentional and non-intentional misuse, and raises both security and privacy issues which must require human oversight for the foreseeable future [20].

There is no currently agreed moral compass for AI at any level – different individuals, cultures and countries do not agree what is acceptable, or what is not, which makes development of new AI challenging. At the moment the ethical and privacy issues are largely in the hands of the AI developers. In addition, there is a growing and significant issue regarding bias in datasets which contain human decisions and are used to train AI. These AI systems don't just mimic bias [21] they tend to accentuate it.

The development and use of AI raises many ethical issues which are extremely challenging to resolve [22]. The use of data can impact privacy and human rights and education is not exempt. For example EU data protection laws have been passed that provide an individual with the right "not to be subject to a decision that is based solely on automated processing" [23] unless explicitly consented to or based on a law, individuals have the right to contest it. In the context of education educational institutions could find this challenging, for example if they don't require students to agree, perhaps on registration, to permit automated marking, students would have the right to question it and that could mean every item of assessment had to be remarked by a human.

5.0 Conclusions

The vast majority of universities still typically have a one size fits all mass tuition system with minimal ability to personalise the learning experience for individual students. However, AI and other information technologies offer the potential to alter

that and this will bring about a huge culture change for both staff and students. It is unclear how this will come about, or precisely when, but is likely to be more of an evolution than a revolution. There are some significant challenges for institutions wanting to engage in this direction of travel, for example, will institutions capture student data and learn from it or will educations AI systems be developed and sold around the world to every university in which case would we need fewer universities going forward? A big challenge in moving the agenda forward is not only the capture of robust datasets in order to train an AI but also the supply of people who can mine that data for appropriate learning [24].

The use of AI in education can not only provide the ability to personalise learning but also to help us understand a lot more about how people learn. For example, if we captured every key stroke and truly understood the behaviour and thinking behind it, we would understand a lot more about how people learn, when they get tired, how the brain responds etc. We would have the potential to understand how and when each individual learner learns best. But also imagine if we could really authenticate who had done the learning and we knew they had achieved a certain level of attainment during the education process, then perhaps we need never assess a student again. Assessment tends to be a hurdle which learners are measured against at a particular point in time. If they fail, they may be given a restricted number of opportunities to attempt an assessment again. This might be for pragmatic reasons in that it is assumed people have put their best efforts in during the first few attempts, and if they weren't successful universities assume they never will be. Why would we not reward learning wherever or whenever it has occurred? People come to learning at different points in their lives due to motivation, personal circumstances etc. and these are just as important for success as a person's innate ability to understand a topic.

However, in considering some of the directions of travel raised above, should we truly have the support of AI in education, it's quite possible that if AI tutors become very sophisticated then universities will need fewer staff and ultimately we may also need fewer universities. The question being, what can humans do that AI cannot? Some predict academia will be unrecognisable within a decade [25]. Key questions are about how fast will universities move and what will drive that change? In order to compete, universities tend to monitor sector movements and norms and ensure they are not left behind. For example, universities typically use a virtual learning environment today, many have moved or are moving to lecture capture, often motivated by behaviour in the rest of the sector. So, when digital assistants become more widespread, it is likely that universities will embrace those as well, potentially with quite revolutionary impacts.

So what does this mean for universities going forward? They cannot ignore the potential impact of AI and other technologies that will support campus wide smart and intelligent systems. However, the applications in teaching and learning aside, universities also need to think about how they educate their students to work in a world where AI is increasingly being used in the career students have chosen and what this means for them. We need to help them prepare for a world of automation

and this should include educating students about the potential impacts and how they can reinvent themselves during their career and truly embrace lifelong learning. Universities also need to think about how they can genuinely support continuous learning, for example more JIT (just-in-time) learning delivered directly to the workplace. Additionally, students need to understand how to work with machines in their chosen profession. As the futurist Kevin Kelly predicts "This is not a race against the machines. If we race against them, we lose. This is a race with the machines. You'll be paid in the future based on how well you work with robots. Ninety percent of your coworkers will be unseen machines."[26].

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Keynote 2

Teaching Useful Knowledge: Some Principles of Useful Knowledge, and Some Classical Ideas about Undergraduate Basics

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Abstract

The qualities of Knowledge are many, and are quantifiable for purposes of reasoning about useful knowledge.
There are some principles of how to teach knowledge which is more universal, for our future 'uncertain futures'; and which will both be useful in the short term (undergraduate and graduate studies) and in the long term (professional lifetime).
A quantitative and rigorous method of considering 'teaching content and methods' options, in regard to multiple 'teaching qualities and values', with respect to Economic and Resource constraints, is discussed.

1.0 What Professors should really Teach: Lasting Wisdom

You should focus your energy on acquiring knowledge with a long half-life.

1.1 Principles of Knowledge, from a Business Graduate Point of View

There are some very basic things that planners should be taught. These things are both fundamental and classic. They are *fundamental* because we can reuse them in a very wide variety of planning situations. They are *classic* in the sense that they have a very long usefulness half-life. They are probably useful for at least a career lifetime.
When I was in my Twenties, I decided to collect, to learn and to develop these planning basics. Now, in my Seventies, I am more than ever convinced that these fundamentals should be shared with students.

The fundamentals are:

- Principles (heuristics, laws),
- Measures (ways to quantify critical factors),
- Concepts (really useful definitions of fundamental planning ideas),
- Processes (really useful planning processes).

I have published these in several books and papers already. I would like to argue here, why they need teaching, in undergraduate studies, for business schools and any planning domain such as information systems and software engineering. I believe that their usefulness and longevity, are demonstrated in my own decades of work, are acknowledged by many professional colleagues and some academics, and are hopefully self-evident upon examination.

My Principles of Useful Knowledge.

- UNIVERSALITY: Knowledge is more useful, when it *applies to more circumstances*.
- ETERNALITY: Knowledge is more worth learning, if it can be *applied for a long time*, after learning it.
- VALUE: Knowledge is more useful, if there is a high *value* from applying it.
- SHARING: Knowledge is more useful, if it can *easily be shared* with others.
- PROOF: Knowledge is useful, when early *feedback can prove its usefulness,* in practice.
- SYNCHRONOUS: Knowledge is more useful, when it can be *used together with a larger body of knowledge.*
- MEASURABIILITY: Knowledge is more useful, when the *results of its application can be measured.*
- ACCEPTANCE: Knowledge is more useful, when it is *widely accepted in your culture.*
- COST: Knowledge is more useful, when the *cost of applying it is low*.
- GENERATION: Knowledge is more useful, when is can be used *to generate even more-useful knowledge*

.

I hope these principles are self-evident observations. I hope that these principles characterize the class of knowledge that institutes of higher learning should be focussing on.

Here is some of my inspiration for suggesting what should be taught at undergraduate level.

1.2 Discussion of my Principles

Here is a discussion of my Principles of Principles, in the light of the Principles of Knowledge, above.

1.2.1. The Notion of Usefulness of Principles:

A 'principle' is a short statement that guides people to take certain decisions or action. It is condensed wisdom. Principles are useful, if they remind us, or teach us, to act in a better way, than we otherwise would do.

For example: The Risk Principle
"There is lots of uncertainty and risk of deviation from plans in any project. You cannot eliminate risk. But, you can document it, plan and design for it, accept it, measure it and reduce it to acceptable levels. You may want to avoid risk, but it doesn't want to avoid you." .
This principle tries to warn about the inevitability of risk. It also is specific about what you can *do* about risk. It teaches that you cannot eliminate risk, but you can try to manage it in various ways.
From the departure point of this principle, the teacher can then be more specific on how to identify, specify and mitigate risks.

1.2.2. The Notion of Half Life of Principles

If a principle were to become obsolete in a few years – perhaps because of new technology or new economics, then it would be less valuable to learn, and might even be dangerous to continue to practice beyond its true lifetime. So I prefer principles that we can imagine 'always were true', and we can so no clear reason why they 'will not be true for the foreseeable future".
I use this as a thought test, for all principles that I publish.

It takes decades, from when a principle is stated, until it becomes taught in any substantial way. The student has decades of their future in which to apply a principle. So it makes good sense that the principle is something we can rely on in the long term.

1.2.3. The Notion of Fundamentality of Principles

Principles should be *fundamental*. They should be basic tools for everyday use in planning, engineering, discussing, decision-making, and reasoning. We should be able to use them as the basis for all our more-detailed actions and thinking processes.
For example: The Principle of 'Quality In, From the Beginning'
Quality needs to be designed into processes and products, Cleaning up bad work is a loser, but cleaning early is better than late. *A stitch in time still saves nine, But an ounce of prevention is still worth a pound of cure. "*

The above principle applies to all planning work. We humans seems to have a strong natural tendency to clean up our faulty work, when faults are discovered, rather than to consciously discover how we can prevent the faults, from getting into our work, in the first place. This principle is fundamental. It is at the basis of all improvement efforts in a planning process. It is the basis for a paradigm shift for many professionals I deal with; the shift from 'fix problems', to 'prevent problems'.
Students should be taught such profound principles, before they waste years discovering them, if ever.
In my book 'Competitive Engineering' I have offered 100 such principles. I have 'brainstormed' many more, in other books and papers, including this one. I am sure many others will continue to develop, principles that deserve to be taught formally.

My concern is that we place far too little emphasis on selecting and teaching these principles. My concern is that students do not even get a dozen good principles, to

base their professional work on. I think we need a course called something like "The Most Important Fundamental Planning Principles".
Practical Tip If you are going to learn a new idea, ask yourself whether it would have worked for the last hundred years, and might well work the next hundred. If not, there may be better things to spend your time on.
In university education, and in Business Corporate Training, we should try to teach powerful, fundamental, eternal principles. Why? Better value for teaching effort More effective for the planner to know if they can apply them

2.0 What Professors Should Really Teach: Clear, deep, useful sets of professional concepts

Principle: Clear concepts, are powerful tools for reasoning. Unclear concepts are a waste of everybody's time.

2.1 Concepts versus Terms

Most planners seem to use a personal, and seemingly accidental, definition of a 'planning concept word', like 'strategy'. They seem *not* be aware, that almost *all other* project participants would *define*, and thus 'interpret' same term *differently*. They seem to *not* have reasonably clear and useful concepts, of the most fundamental planning concepts, such as 'requirement', 'design', 'architecture', 'measure', and 'quantify'.

This section is a comment on *two related but different* notions:
Notion 1. the intellectual necessity, for a professional domain to have clearly defined 'Global' (Planguage concept) domain concepts: a higher-level education *teaching* necessity, in my opinion.
Notion 2. the practical necessity, in addition to the above, of having, in a given planning document, in other words 'Locally' (Planguage concept) *precise pointers* of one kind or another, to *local definitions* of potentially unclear or ambiguous terms. Both these notions are necessary for ease of writing, and ease of precise understanding of a planning document.

The **first tactic**, **Global, definitions**, have the following *advantages*: *Define once, re-use thousands.* A 'culture' (like 'those who use Planguage') can pre-define the several hundred, most-frequently needed, concepts.
This is a one-time effort (and can be instant and free if you adopt a known standard such as Planguage), and can be carefully done by deep experts, or teams. It can be improved over time. But, then, with global concepts defined, the individual planner does not have to 're-invent the famous wheel', 'badly'. And the 'plan reader' does not have to guess, each time, badly, either. With frequent long-term use of a concept, and fairly standard pointers (like 'Stretch Level', written with Capital letters, or bold, or underlined etc. as a formal signal) the plan reader, and writer, can be confident of understanding terms, without even looking terms up.

Unfortunately, there is 'no such thing', as far as I can observe, as a global concept definition set in use for most all management planning. I am sure there are local exceptions, including Planguage, but the normal planning document we see internationally has no such Global Concept glossary in practical use. People 'just use' the same widely-used terms, 'Alignment', 'Mission', 'Strategic' for example with no known reference to any standard, even locally in the corporation, definitions..

The second, subject, **Local Concept definitions**, is a logical necessity for tailoring a plan to current local needs. Planguage is heavily oriented towards local tailoring of concepts, from the vantage point of about 700 Globally already-defined Planguage concepts, as a base.

Practical Tip A: Please do **STEAL MY GLOSSARY**.
You can, freely, without license or permission, take into use our Planguage Concept Glossary, now, and modify it to your needs when you like. Academics and Corporations, be my guest! but it would be nice if you credit the Source! And if you share your version with others freely.

Practical Tip B . **The 'Ambiguity Test'.** As a consultant, I need to dramatically demonstrate to my clients, at meetings, that they *really do not understand* key terms in plans (and one form of plan is a management slide-deck presentation), **in exactly the same way.** So, I will pick a term; hopefully one on which some discussion of meaning has just happened at the meeting. I will also judge, or ask participants, if it is critical, to have a clear agreed definition, of the term. I then ask all participants to write down *their* interpretation of the term. It is important that this is *in the context* of that plan, and a particular organization. Definitions are VERY local! I then ask people to read their interpretations aloud, and I key them in, showing them on a screen, for all to see. What is 'guaranteed', is that no two definitions are *exactly* alike. What is also a pretty sure fact, is that there is no 'official' written definition in the plan, or elsewhere. There is often a local plan glossary; but it fails to cover most all the ambiguous terms! No one can be bothered to define all words used. But the dictionary does *not* contain our local domain interpretation. So the measured density of ambiguous terms is still about 30% of all words used, according to our frequent (SQC) measurements of real plans internationally. In the opinion of top managers who are used to decide what is unclear! Another piece of fun, is when the client or Director's definition is very different from everybody else's.

This **'ambiguity test'** can hopefully result in management agreement to 'get more formal' about defining critical terms, much better. Practical 'clarity' tactics, such as rules about clarity, Specification QC, Defect Exit levels, might hopefully follow. I have a backup plan for the unlikely event that two people ever give me exactly the same definition. I will ask them to define one-or-more words in *their* definition. I do not expect to get identical answers.
The point emerges. We all have different interpretations. If the term is critical to a plan, there is only one reasonable solution. We need to have a formal written definition, in the plan, or a link to it. That will be the 'right' definition. This has legal and contractual implications, of course. But the worst scenario is the cost of lawyers,

billing you at great cost, discussing the interpretation of words, which you *could* have clarified for 3 minutes of work, a year ago.

At a major USA multinational company in Ohio, we used 4 Program managers, checking one page for 30 minutes. Counting ambiguous and unclear concepts in a page of Project Requirements. The 'team' of 4 found about 60 'unique' Major defects in the page, which is about one-third of the defects *actually there* 'right now'. So there are about 180 major defects in the page of about 300 words. This page was about 'quality requirements', including security (example 'use a password'). The project was, as a consequence, predictably (we did the prediction correctly before knowing the truth) two-years delayed (40,000 hours), of which 1 year delay had already been experienced. Planners cannot even seem to get 'conceptual clarity' about *ends* and *means*, since they constantly declare some 'means' to be their 'ends'. The 'use a password' instance, in this case study, instead of a 'Security Objective' definition is a practical example of this mix-up. Planners normally mix strategies, directly, into their statement of objectives, and sometimes, they even forget to mention which objective they are addressing, as in the example about 'password' above.

I have personally given up hoping, that people can agree on the meaning of words. It is not the words that are critical, it is the *concept* definitions that we need to learn. We can then *assign* words or symbols to the concepts, in order to reference them. We can 'declare' in writing, the set of words we use, to reference concepts, in a paper, a book or slides.

My primary concerns are that: *we do not have a* ***rich enough*** *set of planning concepts. For example: We need to distinguish between* ***many types*** *of requirements,* ***many types*** *of designs,* ***many types*** *of constraints – and much more. We use 'words' with no* ***agreed*** *meaning, as though others would know what we mean.*

2.2 Goal Planguage Concept

A goal is a primary numeric target level of performance. An implication of a Goal specification is that there is, or will be, a *commitment* to deliver the Goal level (something not true of a Stretch or Wish target specification). Any commitment is based on a trade-off process, against other targets, and considering any constraints. The specified Goal level may need to go through a series of changes, as circumstances alter and are taken into consideration. A specified Goal level will reasonably satisfy stakeholders. Going beyond a Goal level, at the cost of additional resources, is not considered necessary or profitable – even though it may have *some* value to do so. A Goal parameter is used to specify a performance target for a scalar attribute.

2.2.1 Suggestions to planners and planning teachers and managers.

I would suggest that we need to define our key concepts much better.
Then, we need to teach a decent set of the concepts systematically.
We need to teach them in the context of practical processes for planning.

We also need to teach people to know, *when* they need to define their local use of terms, in their specifications.

Practical Tip C. **Insist on written definitions** *If you are not given written formal definitions, for words, in plans, consider asking for them: and if you can, consider adding definitions to the plan, yourself.*
AVOID ANY CRITICAL PLAN MISUNDERSTANDING ***We will make sure that all terms, critical to a plan, will have proper formal definitions. Either using a corporate planning term glossary, a Planguage Glossary or by specifying definitions in the plan itself.***
Why? Because it is cheap to do, and expensive to have your plans misunderstood. A misunderstood plan, is a worthless plan. Do you really want people to 'guess' what you mean?

3.0 Conclusion

What a Student Exercise Could Teach
1. Stakeholder analysis is the source of requirements
2. Value requirements can always be expressed quantitatively
3. Multidimensional thinking: many values must be considered simultaneously
4. We can and must estimate the multiple effects of proposed strategies / designs / architectures / solutions
5. Very complex real systems can be engineered systematically.

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Competitive Engineering: A Handbook for Systems & Software Engineering Management using Planguage, ISBN 0-7506-6507-6 ,
Software Metrics,
Value Planning ,
Software Inspection, ISBN 0-201-63181-4., Principles of Software Engineering Management,. ISBN 0-201-19246-2 ,

Papers

Learning Anytime, Anywhere: A Journey into Online Teacher CPD

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Abstract

MOOCs (Massive Open Online Courses) allow anyone, anywhere, to access learning materials via online platforms. With a rise in online learning and a growing recognition of how this can support continuing professional development (CPD) in the education sector, in 2016, the GDST (The Girls' Day School Trust) partnered with FutureLearn and launched its first MOOC. By being the only non-university education organisation to offer a MOOC on the FutureLearn Platform and to create courses specifically for teachers, this project and its findings provide a valuable contribution to the growing area of research on MOOCs in a school setting. The MOOC has reached over 16,000 globally.

This paper outlines how the GDST has utilised technology to support our strategic aims of creating a leading educational offer and sustaining an innovative and high performing culture by delivering a digitally-enabled CPD programme. The paper explores the challenges and opportunities online learning offers, some practical advice on developing content to ensure learner retention and finally looks at lessons learnt and next steps. The paper will also examine the value of MOOCs through the lens of offering high quality training to school staff on shrinking budgets.

Keywords: MOOC, CPD, girls' education, online learning, teaching strategies.

1.0 Introduction

Creating and evaluating MOOCs (Massive Open Online Courses) promotes co-operation and greater understanding among practitioners and academics. More

importantly, through evaluation and sharing research and practical experience of MOOCs, the quality of the learning materials is improved. The creation of this format of content, which is consumed by a varied audience of both laypersons and specialists, is dependent on a wide range of skills and is the product of academic research, workplace experience and practical application. MOOCs allow anyone, anywhere, to access high quality learning materials via online platforms, and are an important tool in the democratisation of learning, and a way of exploiting our increasingly connected societies. With a rise in online learning, and a growing recognition of how this can support continuing professional development (CPD) in the education sector, in 2016, the GDST (The Girls' Day School Trust) partnered with FutureLearn and launched its first MOOC.

In order to contextualise this discussion, readers may find it helpful to know about the two key organisations involved in this project. Firstly, the GDST is a network of 23 all-through independent girls' schools and 2 academies throughout England and Wales. Secondly, FutureLearn, our MOOC partner, was founded by The Open University in 2012 and is a leading UK- based social learning platform, enabling online learning through conversation.

The aim of this paper is to contextualise the role MOOCs play in continuing professional development in the education sector, and more specifically, how the GDST's MOOC fits into this landscape. It also narrates our personal journey of creating a MOOC, offering practical insights and presents the evaluation of our first iteration of the course.

2.0 MOOCs, a false dawn?

The term MOOC was coined by Dave Cormier of the University of Prince Edward Island in relation to a course called *Connectivism and Connective Knowledge,* which is widely regarded as the first true MOOC [1]. As this example illustrates, initially MOOCs provided online education in the areas of science and technology-based subjects, and were primarily aimed at Higher Education students, with universities writing content and running courses.

From 2008-2012, the format steadily grew in popularity and according to *The New York Times* 2012 was, 'the year of the MOOC', as top universities began to engage with the format and well-known providers such as Coursera and edX began to emerge [2]. This emergence of MOOCs coincided with a general growth in online learning and greater exploration of techniques such as blended learning, self-paced courses and flipped learning. This combination of interest in, enthusiasm for, and technical expertise with, digital learning, led to what Moody's predicted would be a 'pivotal development' and a 'significant image upgrade for online education' [3].

Recognising this hype and these high expectations for MOOCs, in June 2013, Steel asked the question, 'Will Moocs change the world?' [4]. The motivation behind the article was the recognition that MOOCs were becoming an increasingly 'important topic in academic circles' and 'growing in momentum in the UK.' This article mirrors the then current day anxieties in the Higher Education sector, that traditional university education could be 'replaced' by online learning environments, thus leading to major upheaval and radical educational change in the UK. Steel approaches the subject in a fairly 'black and white' way, an 'either, or' dichotomy being established between traditional university campus style learning and online learning. Her closing remark flies the flag for the university system as she concludes, 'the benefits of a traditional university campus are too many to be dismissed'. Since the writing of that article, traditional face-to-face learning continues to be championed in the UK Higher Education sector, but the first accredited MOOCs (announced in May 2016 in the UK) have heralded a new phase in online learning which further erodes strict boundaries between traditional and digital delivery of content [5].

Looking more specifically at the UK MOOC market, some of the UK's leading universities have been hesitant to join the growing online learning community. It was not until the end of 2016, that Oxford University announced that it would launch its first MOOC on the American owned edX platform, with their first course running in February 2017. Despite being relatively late to offer MOOCs, their motivations for doing so echo those of early adopters, with those involved with the project recognising the course is an 'effective way to expand access to knowledge beyond the classrooms of Oxford', which will help people 'understand how their community and country can flourish wherever they are in the world' [6]. Over the last year, there has been significant growth in the area with the delivery of full degrees online as Coventry University announced its plans to roll out 50 fully-online degrees over the next five years on the social learning platform, FutureLearn [7].

But what role do MOOCs play in the education sector? And more specially, how far do teachers engage with online learning for professional development? Much teacher CPD, including in GDST schools, is still delivered face-to-face in a series of INSET (IN-SErvice Training) days throughout the school year and we also offer a face-to-face central training programme. Despite this largely traditional approach, in-person training can be, and indeed has been, fairly easily supplemented through online courses and less formal online CPD channels such as through Twitter chats, support on forums such as those on the TES (Times Educational Supplement) website and practitioner created videos on platforms such as YouTube. At the GDST, we offer CPD webinars which have proved particularly popular for topics such as online safety, an ever-changing area and one which suits a 'little and often' approach. We also provide access to platforms such as Lynda.com, an online subscription service which offers thousands of video courses in software, creative, and business skills. To complement the GDST's existing online offering, we felt that a MOOC would

allow us to share our research into effective pedagogies for girls more widely across our family of 25 schools and also, with a wider education community.

As part of the planning process, we clearly defined the organisation's motivations for the course, recognising that the creation of a MOOC would be both costly and time intensive, especially with fairly limited resource, as this project fell outside of the scope of the education team's day-to-day work. The aims we identified, in the initial planning stages, were

1. Teachers and education professionals already form a large proportion of MOOC participants, and find it a valuable way of engaging in tailored, on-demand CPD. The GDST MOOC will add a valuable and different contribution to this growing online portfolio of CPD opportunities.
2. Delivering CPD on an open platform gives us the opportunity to share our training courses, knowledge and research with the wider education community across the globe, including in developing countries.
3. Engaging a wide audience of teachers allows participants to benefit from working with a wider learning community, gaining a huge amount from the experiences of teachers in varied contexts and countries and building a peer network.
4. Delivering CPD in an online form gives teachers a chance to experience, as learners, online learning models, thus informing their own practice in designing and delivering online learning for students.
5. The experience of developing and facilitating a MOOC is a valuable learning experience in itself for lead educators, and leads to the development of a huge range of learning materials that could be used effectively in other contexts.
6. As an innovative organisation, we are keen to explore and evaluate the potential of new models of teacher CPD and engage in opportunities for research in this area.

In June 2014, The Department for Education's research report on using MOOCs in compulsory education identified teacher CPD as one of the top three 'overall teaching industry' opportunities in terms of value added illustrating there were high hopes for the format. However, beneath this initial enthusiasm, there were clearly hesitations within the teaching community as comments from the survey noted concerns such as, 'I'm not sure that at the moment you could convince teachers that they could find the time and motivation to do this', or 'they don't like the difficulties that are always encountered in using the technology' and 'face to face is always preferable for CPD' [8].

Despite this hesitation, for a number of years there has been a widespread recognition of the importance of relevant and meaningful independent professional development for teachers, as Donaldson noted, 'long term and sustained improvement which has a real impact on the quality of children's learning will be better achieved through determined efforts to build the capacity of teachers

themselves to take responsibility for their own professional development' [9]. The flexibility that online learning can offer has long been recognised as a benefit of the format, allowing for more flexible and informal working patterns which would seem a highly positive benefit to busy teachers.

Therefore, along with significant pressure on education funding and teacher time, it is unsurprising that both schools and providers are exploring options to deliver cost-effective, relevant CPD to their staff, and therefore increasingly turning to online solutions. With this growing need, teacher CPD and professional development has been identified as a possible 'high potential area' for FutureLearn in their Content Strategy. At their Partners Forum in January 2017, FutureLearn expressed an interest in developing more education focused content alongside their already sizeable and diverse portfolio of teaching related courses. With pressure on schools to provide high-impact and low-cost CPD opportunities and with 20% of FutureLearn learners citing teaching as their area of employment, the GDST began to see the potential of creating MOOCs in this area and the opportunities that working with a MOOC provider, such as FutureLearn, can provide.

And so, it was into this online learning landscape that the first GDST MOOC launched, with more than 8,000 learners joining the first run, including over 230 of our own GDST staff.

3.0 First dawn: our own learning journey

The GDST's course, *Girls' Education: Teaching Strategies That Develop Confidence, Resilience and Collaboration*, launched in November 2016 and has now completed three runs. During the four week course, participants reflected on, and discussed, four pedagogical principals in relation to girls' learning: collaboration, confidence and challenge, talk for learning, and partnerships. Much of the content drew on internally-commissioned research, led by Mike Younger at the Faculty of Education at the University of Cambridge, on 'Effective pedagogies for girls' learning'.

With extensive experience of educating girls, the GDST wanted to be able to share this expertise more widely, but was aware that gender related topics can be plagued by stereotypes and assumptions and can also provoke a range of differing, and sometimes conflicting, points of view. One of our guiding principles, as we created the course, was the recognition that variety in practice is a good thing and there is a time and place for different techniques. Thus we were keen to avoid presenting a 'paint by numbers' approach to educating girls, instead we were looking to display ideas and approaches drawn from academic research as well as GDST experiences and expertise gathered from practice across our family of schools. Rather than providing prescriptive advice, the course put before learners a range of approaches that can benefit girls' learning and each step was designed to be a vehicle to support

educators through thoughtful reflection, sharing of knowledge, and healthy challenge of current beliefs and assumptions around girls' learning.

During the three course runs over 14,000 learners joined the MOOC, from over 140 different countries and participants came from a wide range of backgrounds, including teachers, teaching assistants, trainee teachers, doctors, academics, school guidance councillors, tutors, school governors, retired educators, outdoor instructors, coaches, volunteer workers and charity workers. From the demographic information, it was evident that learners joined from all over the world although unsurprisingly given the content matter, we had a higher than average UK uptake with around 40% of learners coming from the UK compared with a FutureLearn average of 23%. A number of international learners tweeted about the course, with one tweet coming from Ibba Girls' School in South Sudan, where three teachers successfully completed the course.

Another important audience for the course were our own GDST staff. Previously, our research into effective pedagogies for girls was disseminated internally through four face to face training days delivered at our London offices. Through this delivery method approximately 25 staff members across the GDST were able to directly benefit from the training and they were tasked with taking elements of learning back to their school. Although this was effective when a participant was able to identify elements from the course that would benefit whole school foci, it inevitably meant much of the learning taken from the days was dependent on the person attending and the current development needs of the whole school. By moving the content online and enriching it with videos, further reading and discussions with teachers outside of the GDST context, the course content has been made available to more GDST staff members. This allows for a more bespoke professional development offer and is more cost effective, with one teacher commenting,

'I have found this course extremely valuable and interesting and has given me a lot of things to think about and reflect on before the new term… The course has made me think about how I can develop the confidence more of the girls I teach and has provided me with some excellent ideas of how to teach in a different way. Much of what I have learned here I will be discussing with members of my Faculty in our meeting next term and I will be encouraging them to take part in this course when it runs again.'

Enrolment by school into this online professional development opportunity varied across the Trust. This picture however does not necessarily represent the number of teachers within each school being exposed to course content. Some of those enrolled were members of a school's senior leadership team with CPD responsibility, heads of faculty leading departmental meetings and staff involved with action-research. The content has been shared more widely through Teaching and Learning newsletters, whole staff INSET training, drop in lunch time sessions, faculty and department meetings and one to one coaching sessions. Therefore, through both

online and offline initiatives, it is estimated that over 50% of teachers have been exposed to materials and content from the course.

Once learners enrol in a course, the next challenge is how to maintain their interest and engagement. Learner retention and maintaining momentum in MOOCs has been an issue since their very inception. The focus on completion rates as the main mechanism used to evaluate the success of MOOCs can fail to appreciate that for many learners, MOOCs are not 'merely destinations' but provide 'grounds for future opportunities'[10]. Many open courses, the GDST's included, released all video content as downloadable takeaways, along with infographics and a host of classroom based activities and self-evaluation tools. The repurposing of this material and its use in offline activities, isn't captured through online statistics but could arguably be one of the most valuable aspects of the courses for practitioners. From our post-run survey 92% of respondents said it met or exceeded their expectations to add a fresh perspective to their current role.

We were encouraged by our average completion rate of around 15% but recognised early on that the first iteration of the course was too content heavy and time-demanding for teachers to complete during term time. When reviewing the course, our Partnership Manager at FutureLearn discussed course length, and suggested that for particularly weighty courses, it can be preferable to split the course into two three week runs rather than one long six week course, especially for the teaching community where six weeks is often a whole half term. The timing of a course also seems particularly important in an education environment, which is so cyclic, and so timetable driven. We chose to launch our first MOOC in the autumn term in the run-up to Christmas (21st November 2016 for four weeks), as it was towards the end of the autumn term, once teachers had settled into the routines of a new school year, but it is a very busy and demanding time in the school calendar. The second run launched in March-April 2017 and we saw a lower percentage of active learners and completing learners indicating that the autumn term was preferable, although there are many other factors which could have influenced user behaviour in each of the runs.

Another important factor, which may influence retention, is the interactions learners had with mentors, real-time and ongoing facilitation offered throughout the course. We found that engagement with content significantly increased when teachers saw 'mentor' comments in discussions which offered advice on follow-up resources, challenged particular perspectives, or simply offered reassurance on particular pedagogical approaches. This underlines the importance of building a sense of common purpose, mixing theory with practice and ensuing time is built in for discussion and review. Acting as mentors was also an important professional learning opportunity for GDST staff. Qualitative feedback gathered from learners indicated that the course helped them to reflect on their practice, and that a course written and informed by teachers, for teachers, taken by fellow educationalists created a powerful and impactful learning experience,

'This course really made me think about my role as a teacher…The videos and articles are well chosen to promote reflection and interaction with fellow educators. It was most rewarding to share ideas and experiences with colleagues from a variety of contexts which underline the fact that the experiences we share are far greater than any local differences might suggest.'

We also learnt a number of important lessons around recruiting learners as well as retaining them. Being a network of schools, of course we wanted our staff to engage with the content and we created an internal comms plan. Getting the message out there to a busy audience, who definitely suffer from email fatigue, can be tricky, so we put a message on something that no one ignores, our payslips. Although not necessarily the most conventional marketing tool, it proved to be an effective one for us and a fun and informal way of promoting the course.

After each run of the MOOC we made substantial changes and after its third run, we identified that the content and structure needed a more substantial review and redesign. The topics we were aiming to explore; gender in education, female representation in the workplace and gender equality are huge topics, and ones that can be approached from a variety of angles. The variety of the audience also led to changes as we were keen to support parents, as well as educators in this space, and perhaps most importantly facilitate meaningful dialogue between the two. As part of the review process, the weekly workload has been cut by at least two hours a week making it more manageable for learners to engage and we have also sourced new contributors for much of the content to make them more representative of the diversity of the profession.

4.0 A new dawn: what next?

Online learning clearly has significant potential to help support ongoing teacher CPD, but much of this promise is yet to materialise. One of the significant barriers to widespread or institutional-endorsed uptake and adoption appears to be the lack of understanding and experience of online learning from teachers, which in turn impacts on their opinions of the format as a classroom tool. Research in 2014 [11], highlighted that most teachers do not have enough familiarity with, or understanding of MOOCs, to be comfortable using them but those teachers that have tried MOOCs themselves (as learners) are significantly more enthusiastic about the potential to use them in their teaching.

Supporting this view, one of the unexpected outcomes of creating the MOOC has been the interest from GDST schools in creating online learning courses for their students. All of our schools currently have access to a VLE and are already sharing content with students online, with many exploring the social and dynamic aspects that online learning facilitates, such as contributing to blogs, discussion forums and commenting. Taking this one step further, a teaching colleague approached us to explore the option of creating an online course as part of their sixth form enrichment

programme, designed to equip students with the skills, resilience and well-being that today's young women need for a successful career in a highly competitive global economy.

This course has run for two years as a SPOC (Small Private Online Course) on an invite-only basis for all students in Year 12 using the FutureLearn platform. By offering part of a traditionally delivered face-to-face programme as a SPOC, girls will be exposed to online teaching methods used in higher education and work-based learning, hence equipping them with important study skills, quite apart from imparting relevant content in a dynamic and interactive way. Moreover, by moving this part of the enrichment programme online, students will be able to hear from a greater number of voices, for example including more contributions from the alumnae community and be able to share their experiences with one another through social learning.

However, despite some positive outcomes, such as the one outlined above, it is clear that if MOOCs are to become mainstream in teacher CPD, there is still significant work to be done. Moreover, it is unlikely that there is a quick fix or indeed a one size fits all answer for all teacher CPD. However, based on the pilot project in this area, we have identified three recommendations that may help further take-up and adoption

- Development of accredited and/or endorsed courses that link specifically to teacher training and standards. Many university providers of MOOCs have begun to offer ECTS (European Credit Transfer System) for completing courses and providers such as FutureLearn give learners the opportunity to create 'programmes' of study by combining a variety of modules for credits. A small number of teacher-specific courses are already available, but a portfolio of endorsed courses, from high profile and respected organisations such as the Department for Education and the Chartered College of Teaching, is likely to encourage uptake and adoption of online learning.
- Taking into account the current landscape, our experience suggests that the leap to a fully online CPD programme for teachers may be a step too far for many educators. For greater adoption and uptake, schools could see MOOCs as part of a blended learning programme for CPD, starting small by incorporating video content or short self-paced online learning activities with off-line time set aside for peer-to-peer interaction.
- Greater conversation between teachers, schools and training providers to ensure the scope and relevancy of online courses align with needs. There is more work to be done to identify areas for development where massive open learning could fill an immediate and relevant need within the teacher community. We are beginning to see the emergence of these courses, for example, the Chartered College of Teaching is developing a MOOC on

Digital Skills [12], and Raspberry Pi Foundation has developed several courses to help upskill teachers in the computer science curriculum [13].

5.0 Conclusion: a bright dawn?

In conclusion, reflecting on the GDST's MOOC journey, we identified a number of learning points which we will bring to future projects. Overall, the experience of creating an online course for teachers was a positive one and has proved to be an important way to engage with the wider education community. As a small, education partner our experiences of creating and managing these projects differs significantly to those led by more established and experienced teams at Higher Education level and this will be an important guiding principle as we consider scope and capacity going forward.

Based on course feedback, for future projects, we are particularly keen to include access to authentic learning experiences, such as using lesson footage and to include pieces to camera from students, reflecting upon their own experiences, to emphasise the importance of student voice, and once again to add validity and authenticity to the content of the course. Another aspect of course content to consider, is its wider applicability and relevance. The course attracted a diverse audience, including parents and other interested parties, not just teachers. We did not anticipate this and as a result, lots of the activities within the MOOC, assumed learners had access to classrooms and students. Broadening our discussion prompts and using more inclusive language will help support this broader community of learners in future courses.

This project was initially approached as an experiment and learning experience for the GDST. Based on our experiences, by understanding and revisiting, our motivations and aims for creating the MOOC and those of our learners', we have begun to articulate what success looks like for online teacher CPD, although we recognise this format is still in its early stages of development as a universal tool for teacher education.

In early summer 2019, the GDST is launching two new courses. For more information please visit

- Educating Girls: Teaching Approaches to Helping Girls Thrive: https://www.futurelearn.com/courses/educating-girls/1
- Digital Skills for Teachers: Making Technology Work for You: https://www.futurelearn.com/courses/digital-skills-for-teachers/1

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Can Work-related Learning Activities Improve Student Engagement in Higher Education?

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Abstract

Research has found higher education students are typically passive and disengaged. This paper updates and expands upon the author's previous study of engagement issues in universities and the value of work-related learning for improving engagement and enhancing student learning. This previous work involved a case study designed to improve engagement in lab sessions with realistic/real-world work-based examples. While results indicated that activities like this can increase engagement and enhance student learning the study only involved a small sample and there were some areas for improvement. Consequently, the study has been repeated with an expanded case study which takes a holistic approach where students take on the role of an ethical hacker to identify security weaknesses and then fix those security issues. Findings corroborate the previous study's findings and add further weight to the argument that work-related learning activities can increase engagement and enhance the student experience and student learning.

Keywords: Student Engagement, Student Disengagement, Work-related Learning, Passive Learning, Active Learning

1.0 Introduction

Engagement in higher education is important for learning and academic success, and for a positive student experience [1, 2]. Yet, despite this, there is a lack of engagement and attendance among university students [2-4]. Recent findings [5, 6] show improvement in attitudes towards studying but low levels of engagement remain in many areas, such as classroom engagement, time spent on campus, time spent on private study, and use of peer and collaborative learning.

In a previous paper [7] this author showed that work-related learning can help increase engagement and enhance student learning. The study was designed to improve engagement in a lab session by involving realistic/real-world work-based examples based on the hypothesis that students are motivated by career ambitions and wish to see the vocational relevance of their studies [2, 8, 9]. Results indicated that activities like this can increase engagement and enhance the student experience and student learning. However, it only involved a small sample and there were some areas for improvement. Consequently, the study was repeated with an expanded and improved case study to cover additional content to increase learning opportunities, and to establish a deeper understanding of the value of work-related learning.

The improved case study takes a holistic approach, where students take on the role of an ethical hacker to identify the security weaknesses of a website and then fix those security issues. This approach increases learning opportunities by exploring both attack and defence through practical tasks. Students see how easy it is to breach the security of a poorly written/defended website, and then explore the code of the website to see its shortcomings and work on fixing the security problems.

This paper starts by covering the rationale for this study based on academic literature, covering engagement, disengagement and work-related learning. It then introduces the new improved case study and how it builds on the previous study. This is followed by an explanation of the data collection process and the results collected. Findings are then discussed, along with possible areas for future work. Finally concluding with an evaluation of the effectiveness of the study at meeting its objectives.

2.0 Rationale

2.1 Engagement and Disengagement

Interest in engagement in higher education has shown its importance for learning and academic success, and for a positive student experience [1, 2]. Governments use it as a measure of an institution's performance; educational institutions use it as a tool for measuring quality and for marketing purposes; and researchers and educators contemplate the relationship students have with academic institutions, and how engagement can improve students' learning experiences and academic achievements [1, 2].

Despite engagement being an important concept there is little agreement on its definition, and definitions tend to only describe parts of student engagement and approaches to measure it [1, 2]. Schaufeli et al.'s [10] definition of engagement being "a positive, fulfilling, and work-related state of mind that is characterized by vigour, dedication, and absorption" [10, p.465] is a useful basis for a more complete definition. This work is built on by Baron and Corbin [2] who conducted an in-depth analysis of engagement definitions to address the disagreement among definitions and argued that a wider definition is required. This work culminates in their own all-encompassing definition.

> *"…we propose a definition that combines the individual's state of mind with a sense of community. Thus, the definition by Schaufeli et al. [10], together with definitions that emphasise community and social engagement, capture individual engagement for us. Therefore, we suggest that the engaged student is the student who has a positive, fulfilling and work-related state of mind that is characterised by vigour, dedication and absorption and who views him or herself as belonging to, and an active participant in, his or her learning communities."* [2, p.763]

Their substantial work exploring engagement and dealing with disagreements in definitions provides confidence in this being a reliable, accurate and complete definition.

It is not just engagement that is important, disengagement also needs clearer definition. Academics report that there is a lack of engagement and attendance among university students, and students are typically passive and disengaged [2-4]. Issues include students' poor attendance, lack of active involvement in learning, reluctance towards self-study, surface rather than deep approach to learning, inadequate preparation for lessons, spending as little time on campus as possible, and an overreliance on the teacher and teaching material [2, 6]. Recent findings [5, 6] show improvement in attitudes towards studying but low levels of engagement remain in many areas, such as classroom engagement, time spent on campus, time spent on private study, and use of peer and collaborative learning.

2.2 Work-related Learning

University students/adult learners are typically interested in and motivated by seeing the value of what they are learning and how it relates to their lives, with applicability to their future careers being particularly important to them [2, 8, 9]. This aligns with key adult learning theories such as Student-Centred Learning [11, 12] and Andragogy [13] which focus on the learner's personal learning experience, individual educational goals, and learning needs. This suggests orientating academic studies around future careers, such as via work-related learning activities, could aid engagement.

Work-related learning focuses on vocations to provide an understanding of work environments and job roles, and to show how knowledge and skills learned are valuable and can be used within the workplace, linking theory with practice [14, 15]. This learning can come from educational institutions, via work-related learning activities (learning based on work), or as a result of learners working within a work environment (learning from being in work) [14, 16]. Work-related learning activities within educational institutions, which this paper provides an example of, include simulated work tasks, scenarios and environments; role-playing; case studies; and project briefs set by employers [14, 15].

3.0 New Improved Case Study

This paper's case study is based on the author's previous case study [7] that focussed on whether work-related learning activities can help increase engagement and enhance student learning. This new improved and expanded case study takes a holistic approach, where students take on the role of an ethical hacker to identify the security weaknesses of a website and then fix those security issues. This was done to cover additional content to increase learning opportunities, and to establish a deeper understanding of the value of work-related learning.

3.1 The Original Case Study

The original/previous case study [7] was created in response to an identified lack of engagement among university students. It involved creating a lab session which is vocationally relevant with examples that are more realistic to a work environment than a traditional lab session. This approach aligns with best practice for adult education [11-13] and should appeal to university students motivated by seeing how topics covered relate to their lives and future careers [2, 8, 9].

The original case study looked at potential vulnerabilities within web pages and how to protect them. The existing/original lab session involved students writing code to test vulnerabilities and discover how to prevent them. The new lab session involved the identification of security problems via ethical hacking activities where students test a specifically created website's security by trying to exploit its security weaknesses. The existing and new labs were used together and complement each other by looking at security from different angles; defence (existing) and attack (new).

As the new lab session was about attacking websites (identifying vulnerabilities) and the original/existing lab session was about defending websites (preventing vulnerabilities) it would have been good to cover both angles in one session, but this wasn't feasible at the time.

The new lab's tasks were designed to be completed in groups of 3 to a) simulate a development team in a work environment, b) to develop team-working skills, and c) to allow students to help each other to achieve more in the time available.

The lab started with a mini-lecture to provide students with necessary information to complete the lab work. It also included content for a discussion afterwards on defence and how to prevent against the vulnerabilities discovered while doing the tasks.

Following the mini-lecture, the students were given 20 minutes to complete the tasks. This was followed by a discussion on what the students learned and how to resolve identified vulnerabilities. The students were then asked to provide feedback on the usefulness and value of the session, including whether it is useful for helping them enhance their coursework.

3.2 Changes Made for the New Improved Case Study

The study was repeated to address its limitations, to cover additional content to increase learning opportunities, and to establish a deeper understanding of the value of work-related learning.

One of the main issues with the original/previous case study was the illogical ordering of sessions and tasks. Due to logistical reasons its case study lab took place before the related lecture, which is unusual as typically labs occur after a lecture to aid understanding of topics the lecture covered. This meant the lab had to start with a mini-lecture to provide students with necessary information to complete the lab work. The new improved case study addressed the problem by having the lab occur after the related lecture, which is more logical and means learners receive key related information via the lecture prior to attending the lab. Consequently, the mini-lecture was no longer required which freed up time for reflecting on topics, additional tasks, and a more manageable pace. Selected slides from the mini-lecture, with minor improvements made for clarity/understanding, were however provided for reference and guidance. They covered extra content that didn't fit in the lecture and focused on specific aspects relating to the lab tasks.

The original case study lab was treated as a challenge and consequently lab resources (lecture slides and lab worksheets) were not made available before the lab. However, ideally such resources should be available before teaching sessions to allow students to prepare for the sessions should they wish. This is especially useful for students with learning difficulties who may, for example, find reading difficult so would appreciate extra time to read lesson content [17, 18]. Also, while challenging students to identify vulnerabilities within a website could make the lab more enjoyable, the challenge approach could cause unnecessary stress, anxiety and complexity, and prevent students from completing the tasks and learning about the vulnerabilities the lab focuses on. The new improved case study lab addressed the problem by removing the challenge aspect so that releasing lab resources before the session was possible, and by providing additional guidance.

The new case study lab retained the attacking a vulnerable website focus from the original case study to allow for further testing of its work-related learning approach. A second part was added which focussed on defending websites against security vulnerabilities. It involved students being provided with the code for the vulnerable website and being tasked with fixing its security problems/vulnerabilities. This made use of the time saved from the removal of the mini-lecture. Also, this greater focus on defence meant the end of session discussion on defence strategies was no longer required saving further time. Furthermore, it meant the previously used additional disconnected standalone lab with defence focussed tasks (what was the original/existing security lab, prior to both case studies) became no longer required, so could be scrapped, as defence tasks are included in the new case study lab.

Thus, for this new improved case study lab, security attacks and defence are handled via a holistic approach in one integrated lab session improving learning opportunities. While both topics were covered in the original study they were not integrated, and this approach addresses that limitation.

The attack worksheet allowed students to work in pairs if they wished, and many students chose to do this to help each other to understand and complete the tasks, thus retaining the team-working benefits of the original case study lab while also allowing for students who prefer to or need to work alone. The defence worksheet was designed to be worked on individually as students would need to use their individual web server accounts to test out the code they were working on, plus if they were unable to complete this work within the lab time they'd need to complete the lab tasks after the lab session which would be easier to facilitate when working alone.

A major limitation of the original case study, which caused limited confidence in its results, was a lack of participants with only 13 students taking part. This was probably caused by its case study lab being an additional optional session. The new case study addressed this problem by making its lab a regular lab session. 25 students participated and completed the feedback survey which, while still relatively low participation, combined with the original case study's results provides greater confidence in the value of work-related learning activities. It is particularly enlightening where results are similar across both surveys as it shows two separate samples concur.

4.0 Data Collection

Data collection took place during the case study lab sessions, and both case studies were evaluated via an anonymous voluntary student feedback survey. It asked for opinions on statements regarding learning and understanding, session organisation, general opinions, and views on the case study lab versus regular lab sessions; possible responses were Strongly Disagree, Disagree, Agree and Strongly Agree.

Originally a middle neutral opinion "Neither Agree or Disagree" was excluded for all questions to force students to think more carefully about their answers and to avoid indecision and the temptation of answering with the middle/neutral option which is a common problem when surveys have middle/neutral answers [19, 20].

On reflection this approach is not suitable for some questions, such as comparing the new case study lab to regular labs, as opinions could feasibly be the same, i.e. they have no preference for either style of lab. Consequently, for the new study middle/neutral answers were allowed for the questions about comparing the new case study lab to regular labs; although of course it increases the chance of undesirable results. This does however mean for these questions comparing the results of both studies lacks validity as one is not comparing like for like results. A free text box was also included for any comments students may wish to make about the session, such as things they liked or disliked and areas that could be improved.

5.0 Results

5.1 Original Case Study

Results from the original/previous case study were inconclusive as, while they appeared to show that work-related learning activities like used in the study may be able to increase engagement and enhance the student experience and student learning, the study only involved a small sample providing limited confidence in results, and there were some areas for improvement.

5.2 New Case Study

For the new case study, results from the student feedback survey are overall positive and better than the original case study's results suggesting improvements made are beneficial; additional comments (omitted to save space) were also all positive.

5.2.1 Learning and Understanding

Responses for the learning and understanding statements were almost all positive.

72% strongly agreed and 28% agreed the session helped them understand web security better, with no negativity for this statement. This is slightly more positive than results from the previous study that had 61.54% strongly agree and 38.46% agree responses.

However, regarding whether the session improved students' understanding of ethical hacking 64% strongly agreed, 32% agreed, and 4% disagreed. Given the ethical hacking focus of the session this disagreeing, albeit a negligible amount, is confusing, especially as there were no negative responses for the previous study, so perhaps some students didn't realise that tasks set were ethical hacking tasks. However, in comparison to the previous study, over twice as many students strongly agreed with the statement (up from 30.77% (with the rest agreeing)).

All students were positive that the lab would enhance their assignment work with 76% strongly agreeing and 24% agreeing. This is slightly more positive than the previous study, which had 61.54% strongly agreeing, 30.77% agreeing, and 7.96% disagreeing, and appears to show the improvements made to the lab are beneficial and have tackled the previous negativity.

5.2.2 Session Organisation

64% of students strongly agreed (up from 53.85% compared to the previous study) that the session was well organised, and, just like previously, the rest agreed.

Regarding lab materials (worksheets and corresponding lab slides) being clear and informative the majority of students (56%) strongly agreed that they were, and the rest agreed. This is much more positive than the previous study which had the majority of students (53.85%) agreeing (rather than strongly agreeing), with the rest strongly agreeing.

Additionally, regarding information being presented in a concise way the previous study also showed a little less positivity. While the majority of students (61.54%) agreed with the statement only 30.77% strongly agreed and 7.69% disagreed, showing, despite generally finding lab materials clear and informative, some students felt lab materials were not as concise as they would have liked. Some of this lack of perceived conciseness could have been caused by students seeing the detailed explanations used for providing clarity and extra knowledge as excessive so a better balance between detail and conciseness could be required; this was considered for the new improved case study. For the new study, results were much more positive with 68% strongly agreeing and the rest agreeing, thus suggesting the improvements made to the lab materials are beneficial.

5.2.3 General Opinions

When asked if the lab would make them better web developers or designers the majority of students (60%) strongly agreed that it would, with 36% agreeing, but 4% disagreed. This 96% positivity shows the value of the session, and sessions like it. In comparison to the previous study these results are a significant improvement as that study had 38.46% strongly agreeing, 38.46% agreeing, and 23.08% disagreeing.

Regarding the session being valuable the new study had 72% strongly agree and 28% agree, while the previous study had 53.85% strongly agree and 46.15% agree, suggesting improvements made are beneficial.

Similarly, there is increased positivity regarding the session being worth repeating in future years. The new study had 84% strongly agreeing and 16% agreeing, while the previous study had 46.15% strongly agreeing and 53.85% agreeing.

5.2.4 The New Lab versus Regular Labs

Two questions compared the new lab, being a different style, to regular labs. In the new study these statements allowed a middle/neutral answer of neither agree or disagree as it is feasible for students to be indifferent over lab styles. This neutrality was however excluded for these statements in the previous study which was an oversight that the new study addressed. It does however mean direct comparison of results from the two studies for these statements is difficult and lacks some validity.

When asked about if they (students) felt they learned more in the case study lab compared to regular lab sessions there was no negativity, as 20% strongly agreed, 40% agreed and 40% neither agreed or disagreed. In comparison to the previous study these results appear to be more positive as there is no negativity, whereas the previous study had 23.08% disagree (with the other results being 23.08% strongly agree, 46.15% agree, and 7.69% gave no answer).

However, the middle/neutral answer option being unavailable for the previous study could have influenced these results. For example, were students overly positive or negative when there was no middle/neutral answer to choose. Likewise, when the option was available with the new study students could have chosen it instead of being negative due to not wanting to offend the teacher. Also, one could view the neutral "neither agree or disagree" option as a pseudo negative response as students don't want to commit to a positive response; but it can also be considered positive as respondents don't feel strongly enough to commit to a negative response.

Comparing the strongly agree and agree responses, these are slightly higher for the previous study, so maybe the lack of a neutral answer forced increased positivity; but there was 23.08% disagree, while there was no disagreement for the new study. So, it could be that the neutral option, being available for the new study, was chosen instead of being negative, or was the new case study lab better received and there was no need to be negative or students were indifferent over lab styles and given that there was no negativity at all this seems most likely.

When asked if they enjoyed the lab more than regular lab sessions students were a lot more positive about the new case study lab with 48% strongly agree, 32% agree and only 20% neither agree or disagree responses. In comparison to the previous study, which only had 7.69% strongly agree but with 76.92% agree, and disagree and no answer both having 7.69%, the positivity is almost the same (80% vs 84.61%), but with a lot higher strongly agree responses for the new study. The lack of negativity was also encouraging, but it may be the neutral response was used as a pseudo negative response.

Results across both studies were positive, with increased positivity about the new case study's lab indicating improvements made were well received, which is a strong endorsement of the session's approach compared to regular lab sessions.

6.0 Discussion and Future Work

Student feedback for the new case study lab was overall positive, corroborating findings from the original/previous study, showing the aims of the session have been met. The results are better than the original case study's results suggesting improvements made, such as security attack and defence now being integrated into one holistic lab session, are beneficial.

Informal observations showed students were engaged, and their survey responses show they enjoyed the lab and overall saw value in it. Additionally, the survey results show students felt they learned the skills the lab aimed to teach and that it would help them improve their future work. The informal observations also showed students understood the topics covered and could complete lab tasks. There were no strongly disagree responses for any survey question.

Negativity has been significantly reduced, and in most cases removed entirely, and where negativity remains it is a negligible amount. These small areas are 4% disagreeing that the session improved understanding of ethical hacking, and 4% disagreeing that the lab would make them better web developers or designers. While an insignificant amount one could still attempt to tackle this negativity, by for example improving session introductions to explain their relevance and value better.

While only 25 students participated in the study its findings, combined with the original case study's results, add further weight to the argument that work-related learning activities are valuable, are enjoyed by students, and can show the relevance of what is being taught. This appeals to students increasing the likelihood of student engagement, and informal observations showed engaged students, and enhances the student experience and student learning. A larger sample was originally planned but unfortunately session attendance was low.

This was only one session with a small number of students therefore to properly assess the value of work-related learning activities a wider sample over multiple sessions would be advantageous. This will provide a larger sample size, the ability to assess progress over a longer period including use of more complex assessment, and more results to allow for a deeper analysis to take place. Also, one could consider making further improvements to tackle the, now extremely small, areas of negativity.

7.0 Conclusion

This paper updated and expanded upon the author's previous study of engagement issues in universities and the value of work-related learning for improving engagement and enhancing student learning. The study was designed to improve engagement in a lab session by involving realistic/real-world work-based examples based on the hypothesis that students are motivated by career ambitions and wish to see the vocational relevance of their studies [2, 8, 9].

The original/previous case study's results indicated that activities like this can increase engagement and enhance the student experience and student learning. However, it only involved a small sample and there were some areas for improvement. Consequently, the study was repeated to address its limitations, to cover additional content to increase learning opportunities, and to establish a deeper understanding of the value of work-related learning.

The case study was improved and expanded by taking a holistic approach, where students take on the role of an ethical hacker to identify the security weaknesses of a website and then fix those security issues.

Student feedback for the new case study lab was overall positive, corroborating findings from the original study, showing the aims of the session have been met. The results are better than the original case study's results suggesting improvements made, such as security attack and defence now being integrated into one holistic lab session, are beneficial.

While only 25 students participated in the study its findings, combined with the original case study's results, add further weight to the argument that work-related learning activities are valuable, are enjoyed by students, and can show the relevance of what is being taught. This appeals to students increasing the likelihood of student engagement, and informal observations showed engaged students, and enhances the student experience and student learning. A larger sample was originally planned but unfortunately session attendance was low.

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Teaching Computational Thinking via Tangible and Graphical Interfaces – An Overview Through Reflective and Critical Lenses

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Abstract

Deep learning and conceptual understanding are essential and critical elements for achieving learning process improvement in Computational Thinking (CT) curricula. For successful learning outcomes the school teachers of programming most probably have to familiarise themselves with two essential learning frameworks: i) tangible programming interfaces (TUIs), where real world objects are utilized to fulfil the programming process and assist in children's abstraction skills; ii) graphical user interfaces (GUIs) or visual programming languages that involve the task of creating a structured program through the combination of graphical elements on a program canvas. Hence, this paper introduces the importance and readiness of teaching the programming concepts comprising CT in a creative and natural way. The authors present the rationale and current formal ways for teaching programming to primary school pupils. After a critical overview of some learning programming

environments, the authors present and scrutinize the results between tangible and graphical interfaces (visual learning) from comparative studies.

Keywords: Teaching Computational Thinking (CT), tangible/graphical programming interfaces in education, reflective and critical literature review/overview, Science, Technology, Engineering and Mathematics (STEM) subjects.

1.0 Introduction and Research Rationale

Digital literacy is the ability to understand and use digital technologies effectively for everyday tasks. Programming concepts and computational thinking (CT) have an influential presence in digital competencies and in the schooling environments of the 21st century. CT and logic, along with analytical, social and communication skills, are often considered as the basics for achieving a successful education in Science, Technology, Engineering and Mathematics (STEM), for boys and girls. This is a challenge for IT professionals who teach nowadays' school boys and girls. The primary school teachers and their pupils are surrounded by various computer-based technologies and the school students will possibly have a future job that has not, yet, been defined. Introducing the core concepts is a challenging task for the teachers who will need collaborative pedagogic approaches requiring the learners' full attention, curiosity and participation.

Notwithstanding, 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 for the future citizens?* The answer is not simple. Generally speaking, CT involves a set of skills that include problem-solving, design, and systematic analysis [1, 2]. CT represents a type of analytical thinking that shares many similarities with mathematical thinking (e.g., problem solving), engineering thinking (designing and evaluating processes), and scientific thinking (systematic analysis) [1, 2]. While the act of engaging in CT is rooted in computer science, some have argued that it is a skill that is fundamental for everyone to master, just like reading, writing, and arithmetic [3]. In a pivotal article on the need to expand the reach of CT, Jeanette Wing [3] states that it represents a universally applicable attitude and *skill set for everyone*, not just for computer scientists [4].

There is a growing pressure to teach CT already in early elementary school, and this has put teachers, administrators, and parents in a difficult position when investing in technology for early childhood education. These adult groups have to cope with an ever-changing array of digital tools now being marketed to this school age group. The above groups face questions such as, "what CT skills are my children actually learning with this tool?" or "will my child find this tool fun and engaging?" "How can I successfully integrate it with my curriculum?" When choosing tools for school or home, parents and teachers must also navigate the choice between screen-based and non-screen-based technologies that are quickly spreading out [4]. Thus, teaching CT at schools is argued to be necessary but also admitted to be a very challenging task. Not only because there is no general

agreement about what computational thinking is but also because there is no clear idea nor evidence on how to teach CT in an effective way. There is a need to develop a shared understanding of the effective ways of teaching CT at schools [5].

2.0 Aims, Research Questions and Background

The main aim of this research study is to provide an overview of the current work carried out in the teaching of CT with Graphical and Tangible user interfaces. Programming has an enormous presence in people's everyday lives of the 21st century. Digital literacy is as important for children today as reading and writing skills were once. [6]. However, computational thinking is still in its infancy. But its status is increasing in education [7, 8] and many countries are updating and renewing their national curricula with different strategies by emphasizing on digital competence [9]. Moreover, computational thinking is declared as one of the key skills for the future workforce [10]. This puts the teaching of computational thinking as a top priority in formal education.

2.1 Research Questions

The aims of this literature review can be expressed through the following research questions:

RQ1) Which Graphical and Tangible Interfaces exist to teach children Computational Thinking and

RQ2) What features/mechanisms do GUIs and TUIs offer for facilitating CT?

The next three sections offer a general introduction and historical perspectives of GUIs, TUIs and CT.

2.2 Graphical User Interfaces

Graphical or visual programming involves the task of creating a structured program through the combination of graphical elements on a program canvas or timeline. Through intuitive graphical representations of programming concepts, a user can put together some kind of programming puzzle on screen and thereafter observe its execution on the screen. Little or no typing of commands is required to complete the above task. The creation of graphical programming tools for children is a wide field of research since the early 1960's. Based mainly on graphical interfaces and utilizing the theories of constructivism by Papert [11], a large number of programming languages was created for both children and novice users. These graphical programming approaches incorporated simple syntax, nested loops, and control structures through graphical representation, allowing children to program by dragging and connecting icons on computer screens [6].

2.3 Tangible User Interfaces

Tangible user interfaces (TUIs) for programming, on the other hand, appear to be a rising field that offers unique opportunities for learning. In many cases researchers tried to teach either simple programming concepts by guiding graphical representations on a computer screen or simulate and program advanced concepts, like physical motion using TUIs [12]. In almost all cases researchers took

advantage of the facts that TUIs convert physical objects into programming elements and that may reduce the age threshold for participation in activities. Moreover, similarly to the construction of a robot, tangible interfaces may offer equal opportunities for participation and active learning [11, 12]. Consequently, the combination of robot construction and programming through tangible interfaces might be an attractive, easier, collaborative way to lead young student and novice adults to the world of CT. [12] Tangible user interfaces were initially defined by the work of Ishii, H. & Ullmer [13], and created excellent opportunities for the pioneering implementation of technology inside school classes [14]. An area that seems to have benefitted by this kind of technology is that of tangible programming environments, with applications mainly to education, but not exclusively to it [15, 16].

2.4 Computational Thinking through User Interfaces

CT in education has recently gained popularity. Currently, CT has been mostly studied in secondary and tertiary levels, but much less in primary level and least at pre-school level. Integrating computational thinking in education also varies from preferring shorter and simpler activities to using more extensive and longer activities. The lack of skilled teachers and the difficulty to choose among many available tools for teaching CT have been identified as common educational challenges [17, 18, 19]. Nevertheless CT in education is popular because it is, naturally, a set of mental tools and strategies that can consciously be applied in problem-solving situations [5]. Accordingly, graphical user interfaces in the form of programming applications on tablets and computers have become popular in recent years, due to new federal and private initiatives making technological literacy a priority in schools (see e.g. [4, 20]).

Since Wing [3] popularized the term “computational thinking”, which was coined by Papert in 1980 and in 1996 [5, 11] there has been confusion about what exactly CT means. Papert associates clearly CT to generative and generic mathematical thinking and associated mathematical education. Jones [20] argues that Wing never really gave a solid definition of what exactly CT is; only a number of characteristics of CT. 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 “for everyone, everywhere” Yet, humans think in a very large variety of ways. [5].

Computational thinking is a term to describe a set of thinking skills, habits, and approaches that are integral to solving complex problems using a computer and are widely applicable in the information society. There seems to be a growing consensus that CT is a fundamental (thinking, analytical, design and modelling) skill that everyone needs in our complex and technological culture. CT makes it possible for children to improve the analytical ability that may be helpful in STEM (science, technology, engineering, and mathematics) subjects and many other professional areas, even in daily life. The advantage of this early exposure to CT is that it will help children to build a solid foundation of algorithmic and data structures—the basic nuts and bolts of the mechanics of computer programming. Computer programming is an excellent way to develop CT skills [21, 22].

Thus, programming and modelling skills and associated CT 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. [5]. In relation to thinking and problem-solving, CT can be introduced around two distinct teaching programming paradigms, these of graphical/visual and these of tangible interfaces. The next sections elaborate to search, find and present such teaching environments examples and refer to their features in attendance to a tabular representation.

3.0 Research Methodology and Research Scope

For the context of this research study, we only focused on research studies that i) were related to the teaching of the concepts of computational thinking through graphical and tangible interfaces and ii) had already been used and studied for teaching programming to children.

3.1 Search Terms and Resources Searched

Initially, the main search was made with the help of the Google Scholar international online bibliographic database utilising the principles of systematic literature reviews [23] and also through a peer reviewed search with ERIC. Our searching key terms were: "Computational Thinking" as an exact phrase and following terms included at least one of the words "Tangible" or "Graphical" and also in combination with all of the terms "children", "programming" and "interface". The authors decided to examine the relevant (containing all the above terms) to our research published material from January 2002 to September 2017.

3.2 Final Research Artefacts Selection

A first step was to exclude papers describing case studies in process, posters, conference reports, and not related to the graphical/tangible interfaces and computational thinking papers. Afterwards, based on the papers' abstracts, we excluded those articles that were irrelevant to programming curricula and tools and did not focus on children students learning. The authors, then, read through and considered the content of each article in order to explore the various technology-based pedagogy approaches used in the teaching of computational thinking through programming. A total of 1242 entries appeared after a Google Scholar search, which combined all secondary search terms with 'computational thinking', and which resulted in 118 relevant papers after eliminating by title and removing those that were clearly not related to our focus study. After excluding the papers that were not related to the teaching of computational thinking and also removing all the papers that did not have an evaluation with a group of children, five papers were kept, which we mostly consider in this research study. Figure 1, next, summarises the research papers selection process.

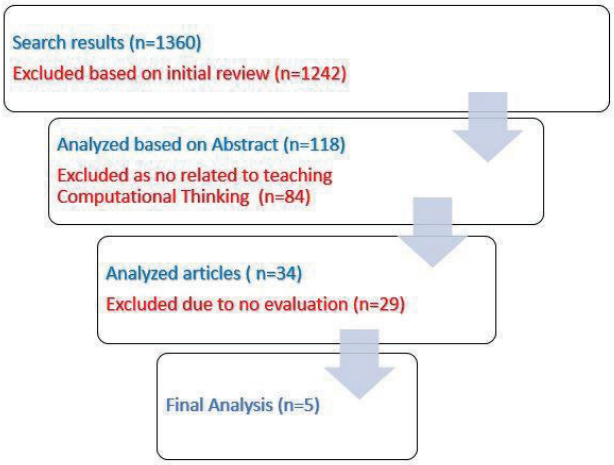

Figure 1. Papers Selection Process

3.3 Research Results

One can observe that introducing and teaching CT to children in an enjoyable way is an interesting and demanding issue. The authors found several published works dealing with programming tools for teaching the concepts and principles of CT. The next section provides a reporting review of the focus and attention of those papers.

3.3.1 Graphical/Tangible Interfaces Evaluation for Teaching CT

A number of approaches have exposed the principles of CT with graphical or/and tangible interfaces. The next section describes briefly the main features and usage of each of the pedagogical construction objects that are considered above, considering their classification to tangible, graphical and hybrid user interfaces.
Table 1 provides an overview which at the same time serves as a broad taxonomy on the interfaces used for teaching CT to pupils of different ages.

3.3.2 Results related to Tangible and Graphical User Interfaces

KIBO: The system (see Figure 2) is based on a robot with accessories to support personalization and a collection of wooden bricks that represent the available commands. Each wooden brick has a separate barcode sticker while for the program creation the users/learners need to assembly the bricks in a logical sequence. For the program recognition, users need to scan each wooden block using the scanning system which is embedded on the robot [22].

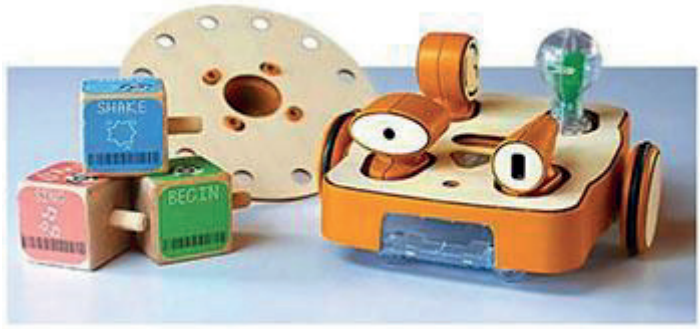

Figure 2. KIBO

ScratchJr is another introductory programming language for the iPad and Android tablet that enables young children (age 5-7) to create their own interactive stories, collages, and games [4].

T-Maze, TanProRobot: These systems were designed by the same researchers [4, 21]. T-Maze is a tangible - graphical game through which children try to guide a virtual character to escape from a virtual maze. Their latest release is *TanProRobot,* an active programming language with a real robot. [21].

CTArcade: This is a gaming environment that enables children to articulate CT-related thinking patterns and conceptualize them as formal logic. [24].

CyberPLAYce: It is a tangible, interactive, cyber-physical learning tool for children supporting computational thinking and playful storytelling in particular. [25].

Table 1. Interfaces for teaching CT to children.

Name	Interface	Approach	Category	Level	Evaluation
ScratchJr	GUI	Individual	Application	4-7 years old	28 children
T-Maze	Hybrid	Group	Wooden Blocks	5-9 years old	20 children
CyberPLAYce (B-1)	TUI	Pair	Panels	8-12 years old	6 pairs of children
KIBO	TUI	Pair	Wooden Blocks	4-7 years old	322 children 60 pre-kindergarten
CTArcade	GUI	Individual	Web-based	10-15 years old	18 children

3.3.3 Hybrid Toys and Hybrid Interfaces

Notably, a number of the pedagogical objects/toys fall under the category of hybrid objects, which expose a combination of visual/graphical and tangible modes of interaction. Some tools, such as *TanPro-Kit, Makey Makey*, and *LEGO WeDo* allow their end-users to manipulate tangible objects and view the results on a traditional 10 visual-based display. Similarly, *TanPro-Kit*, developed by Wang et al. [21], is a set of visual programming blocks with a LED pad that presents visual animations and audible feedback according to the arrangement of the blocks. Unlike *TanPro-Kit*, the *Makey Makey* kit is, now, commercially available. Originally designed in an MIT Media Lab, the *Makey, Makey* invention kit is now sold by JoyLabz to help adults and children of age 8+ to explore art and engineering. The *Makey, Makey* platform allows users/learners to turn everyday objects into touchpad inputs. The *LEGO WeDo*, sold by LEGO Education and made for children of age 7+, is both a construction set and a visual blocks programming interface that enables learners to design, build and program simple LEGO models. The *LEGO WeDo* is an incredibly popular environment because of its familiar LEGO platform; and it is most commonly used in schools and workshop settings.

Other hybrid technology toys include programmable robots, which have visual input interfaces and tangible output. For instance, the *Robo-Blocks* interface is a programming interface that allows the learners to create a program by connecting physical command blocks and wirelessly control the motion of a floor robot. *Sphero* is a commercially available programmable sphere for children of age 8+. As a spherical robot that can be controlled from a smartphone or tablet application, the *Sphero* can change colours, move towards every direction, and even jump! Similarly, *Bo and Yana*, designed for children of age 5+, consists of a robot and a visual programming interface that helps kids to learn how to code by controlling robots and creating stories and animations. [26].

4.0 Critical Appraisal on the Research Findings and Comparative Related Research

In the previous sections the authors observed a number of visual/graphical or tangible pedagogic innovations in the teaching of CT that have gained popularity. Attention is also paid to hybrid toys and systems e.g. the combination of tangible interfaces and robots opens new avenues in the field of Educational Robots (ET). [12, 14]. Educational robotics can prove to be a new innovative instrument for education and learning. The scope of ER is definitely to enhance higher level thinking skills and abilities through robot development and programming. The programming languages used for ER at the moment are based mostly on graphical user interfaces. Simultaneously the field of tangible programming appears to evolve and might offer new ways of interaction between robots and students. [14].

Although TUIs and GUIs designers have developed a series of educational (hybrid or not) systems, there are many open directions to further research and development. On one hand, more simple, sophisticating and less complex pedagogical tools should be available in schools for teaching CT and on the other

hand there is a need to provide empirical evidence that may clarify the circumstances under which tangible and intangible programming languages and interfaces offer more benefits in a real class context. Even though tangibles are believed to be more efficient (easier for younger children) than graphical user interfaces, there is limited research that systematically explores the cognitive and social advantages of TUIs compared to traditional GUI solutions. [12, 14].

Tangible technologies have also grown in popularity in recent years, especially after the recommendations from the American Academy of Pediatrics in 2003 for reduced/limited screen-time for young children. New robotics kits have evolved to become a modern generation of 'learning manipulatives' that help children to develop a stronger understanding of mathematical concepts such as number, size, and shape in much the same way that traditional materials like pattern blocks, beads, and balls once did [1, 2]. Tangible robotics kits may also expose young children to different kinds of learning. For example, tangible robotic manipulatives allow children to develop fine motor skills and hand-eye coordination while they are engaging in collaboration and teamwork [1, 2, 4].
A tangible programming environment may have the same usage results with a text-based or graphical-based programming language. The peculiarity of tangible environments has to do with the fact that instead of using graphical on-screen objects or selecting on-screen commands, real-world objects are being utilized to fulfil the programming process [6]. These results and observations, albeit from pilot studies, give us some assurance that the technical affordance of the platform will allow the learning community to generate engaging products that will get more kids falling in love with coding and exploring deep ideas in computational thinking and modelling. [27].
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)!

Apparently there seems to be no 'current top expert' to define the apparent need and relation of CT and digital literacy, but tentatively speaking the digital literacy's preliminary role seems to be somewhat parallel with CT. 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 [5] 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 teamwork-based 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 CT there are parallel dimensions.

5.0 About and Beyond CT and Learners' Interfaces

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 are used 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: *a) Will the mental tools and strategies of CT be applied? b) Does the possibility of application occurs in the individual learners' conscious minds?*

It is understandable to take the previous 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.

It is a great educational challenge for IT professionals to design appropriate educational systems, practices and activities as well as tools which give a convincing answer to the question like what is it to learn for an unknown future.

Regardless the great emphasis on the need to different sets of skills, which can be very useful for many purposes, it must also be understood that the idea of CT skills without manifold (critical, creative, reflective, and caring) thinking [28] is not educationally very sound. That is, educators must focus not only on what is useful but also on what is necessary to prevent future citizens from possible misuse of competences, knowledge and skills.

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.

6.0 Limitations of This Review

Through conducting a literature review of research studies referring to tangible and graphical interfaces for teaching computing to children, several positive and negative characteristics have been revealed. For example, a number of researchers, also considered in our sample, have argued that 'tangibles', in general, have been the ideal choice for children in teaching abstract concepts because they are more understandable and usable by children. However, there are limitations to the work presented in this literature review study, which influence the direction of the research being conducted. Firstly, many of the tangible and graphical interfaces developed by many researchers do not make it to the commercial market; often they are innovative prototypes in a research environment. Secondly, due to the nature of working with children and prototypes, the children are introduced to the tool by the researchers. [29].

Related to this is also the fact that there is limited research into how teachers are using tools and methods for teaching computing. Recent analyses into papers published on Computer Science education research found out that only a small percentage of the related research studies were focused on computational thinking (4%) and teachers (18%). This is also supported by Bocconi et al' s [30] investigation, which found out that there has been a lack of research into the development of support measures for teachers teaching computing and incorporating CT into the classroom through other than programming ways. [29].

7.0 Summary and Future Research and Development

In this review paper, the authors examined the concepts of tangible programming languages and graphical user interfaces for teaching computational thinking. The

authors also proceeded to a short research review on the field's related research outlining findings and insights to the possible benefits of tangible and graphical ways of teaching CT. It is rather less common to see computational thinking learning environments and pedagogy designed specifically for young children while assessments that are developmentally appropriate for this demographic are even sporadic [31]. Nevertheless, computational thinking is a key competency for the 21st century's children. Further, CT is a skill that should be included in the curricula and be taught to students of all ages.

Based on the findings and identified gaps on the learning needs, the authors suggest that a coherent proposal aiming at an integrated pedagogic application should be realised. This should lead to a fully introductory programming ecosystem that could be considered as a bridge between tangible and graphical solutions in teaching CT. This novel teaching CT pedagogical framework can be utilized as a learning platform to introduce the basics of programming logic with an easy and interactive way. Thus, primary school boys and girls will be able to conceptualize, reflect on and understand better what happens inside a computer (machine) with hands on experience and also improve their general abstraction STEM-related skills by playing creatively through a friendly interface.

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 so that many require from ordinary citizens to have some knowledge of computer technology. Thus, programming skills, computational modelling skills and associated manifold 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 question "*how to teach programming and CT and who could teach them best?"* still remain and need to further be researched, particularly in practice.

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The perceptions of technology for education, a Generation-Z case study

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Abstract

As Millenials begin to leave university this paper focuses on the following generation, Generation Z, the oldest of whom will be entering higher education in September 2019. This paper is a case study of a young woman on the crossover point between youngest millennial and oldest Gen Z. Through discourse analysis this paper endeavours to explore their perceptions of technology, the need for technology in higher education and the shape they believe this should take.

Keywords: Generation Z, Undergraduate, Social Media

1.0 Introduction

As the last of the Millennial generation cohorts progress through university, the next generation (Generation-Z) are completing their UCAS forms. For those involved with teaching and learning in higher education institutions the discussions on how to engage with Generation-Z must be held in earnest. Generation-Z in the United Kingdom grew up with broadband (by 2007 half of all homes had the potential for broadband access [1]) and the rise of smartphone technology (with the first iPhone released in June 2007 [2]); social media for this generation was not something to be developed and sculpted but a matter-of-fact digital world which they inhabit. As such the way in which technology is used for Generation-Z's educative life should now be a hot topic of discussion.

It is important to clarify what is meant by two terms: Generation-Z and Millennial. The terms are fluid and there is currently no academically agreed date range for these generations; they are sometimes even combined with Generation X to form a mega-cohort. In the wider world of research some argue that any born between 1977-1994 are designated a Millennial [3], whereas the Pew Research Centre use the date range 1980-1996 [4]. Neil Howe in Forbes[5] suggests that 2005-6 be the start of the Generation-Z (or homeland generation - though notably the term homeland generation is remarkably USA-centric as it focuses on USA homeland security [5]),

whereas others [6] suggest that perhaps the next generation consists of those born after 2000. As can be seen the precise makeup of Generation-Z and the previous generation is up for debate; for the basis of this paper the term millennial will refer to those born between 1980-1999, whereas Generation-Z is those born between 2000-2019.

Another term bandied around is digital native. The term is commonly attributed to Prensky [7] and is used to describe the generation that grew up with an Internet connected home and/or school life. These children had computers, phones and Ipods and as Generation-Z take centre stage these devices and their users' interactions with them are in the words of Prensky causing a “discontinuity” [7]. The digital native is technologically savy with an almost innate ability to use the technology at their fingertips [8]. However it is worth noting that digital native is a loaded term; firstly the concept of an entirely digitally-connected generation does not take into account the digital divide, ignores gender dynamics [9] and glosses over the multifaceted access issues surrounding technology [10]. Secondly the very terminology used - “Native” and “Immigrant” [7] - are fraught with colonial baggage which further compounds the lack of reflectivity on the digital divide and the global uptake, use and exposure to technology by the youngest generation.

Literature is beginning to appear on Generation-Z as learners entering adulthood, though not yet in abundance. Writing while Gen-Z were in their infancy Prensky [7] talks of a generation that has not only grown up with the Internet but has never experienced life without it. Palley [11] discusses how, as a generation, Gen-Z are the most comfortable and au fait with the technology that surrounds them. In their book Seemiller and Grace[12] dig deep into what the Generation-Z student required from education; Gen-Z's preferences move away from collaborative learning and focus more on self-led self driven learning. With this in mind it comes as no surprise that Seemiller and Grace [12] also report that Generation-Z prefer to avoid lectures in favour of self-driven learning via YouTube. It is Generation-Z then that has grown up to be the digital generation but whilst academics were building a social image of learning such as the digital learning model connectivism [13] Generation-Z appear to be focused more on learning technology they can control for individual studies.

In order to address the gap in the literature this paper will take a Foucauldian Discourse Analysis approach, through a single-case case study. Within the majority of discourse analysis it is not usual to have a hypothesis but instead the research is driven by a number of research questions. The questions that drive this research are as follows:

1. How do Generation-Z view technology with regards to education?
    1a. How do they currently perceive their use of technology?
2. How do Generation-Z envision technology to be used at their future educational institutions?
3. How do Generation-Z perceive the role of social media in their education and their engagement with educational institutions?

2.0 Methodology and Theoretical Framework

The theoretical framework for this study is post-structuralism and in particular Foucauldian Discourse Analysis. Post-structuralism is at its core not a set theory or framework but a collection of concepts, moving away from the more rigid truths and theoretical rules of modernist thought [14].

Michel Foucault's work focused on discourses, how things are perceived and how these discourses and perceptions change over time. His 1967 work [15] is a prime example of this in its review of the perceptions of, and discourses around, insanity. To fully understand Foucault and Post-Structural Discourse Analysis it is vital to examine what is meant by discourse. A discourse in this context is not merely the conversation around a topic but the themes that are apparent within it. Discourses can be conflicting, changing and fluid within a topic; for example on the topic of the use of laptops in the classroom the discourse might include themes such as disability, attention, and methods of learning.

There are two key points around post-structural discourse analysis pertinent to this paper. Firstly post-structuralism is non-hierarchical in that no voice in the discourse is more important than any other. Within Foucauldian Discourse Analysis the focus lies not on the main voices in the discourse but on those voices that are marginalised or overlooked. Thus when looking at technology in education the focus lies not on the higher echelons of the university system or with the teaching and learning coordinator but with the students themselves.

The second aspect is that Foucauldian Discourse Analysis promotes the in-depth study of discourses and voices by focusing on low number cases studies [16]. Rather than try to have 10 voices in the discourse which would prove unwieldy to analysis, unless one is planning on writing a PhD on the topic, the post-structural method focuses on low numbers of voices to fully engage with what those voices are saying. In the case of this paper a single point of discourse is used.

2.2 Participant

The participant is an 18 year old girl Alix (name changed to ensure anonymity).

2.3 Design and Method

The design for this research is a single person in-depth case study. The data collection was done via online contact through email messaging and WhatsApp. The tools for this research were a single 17 item open-ended questionnaire. In order to conduct this research Alix was approached by the researcher. Once Alix had given consent to participate in the study she was sent the research questions via email. These questions were returned to the researcher for analysis.

2.4 Ethics

To ensure full disclosure an issue in ethics must be noted here. Alix is a friend of the researcher, however a number of steps were taken to fully inform Alix of her participation and to ensure ethical standards according to BERA (British Education Research Association) [17] were met.

As a post-structural researcher using data sourced from a friend there are some potential issues with the analysis and remaining impartial, this is well recognised as a potential issue in any ethnographic work [18]. The method of mitigating this issue was through reflective diaries (please see 3.0 Analysis for further details) and through being mindful and aware of my own place as both friend and researcher (for further understanding of the researcher/friend-family dilemma please see Enslin [18])

3.0 Analysis

The method of analysis is based on Foucauldian discourse analysis [16]. There are several stages to the analysis which are as follows:

The first step in the analysis is to read through the completed data set – in the case of this research the answers supplied by Alix. Once the researcher has a clear understanding of the material, analysis can begin. The second step is to create summaries of the data, these are breakdowns of the exact content of the text. The third stage is based on finding key words and phrases that come up in the text – these form the basis of the themes and discourses.

The Reflective Diary is further used at all stages of the analysis to record any conflicts or personal interactions with the data. This allows the Post-Structural Researcher to be both embedded in the data and to be one staged removed. The Diary enables the Researcher to acknowledge and process their own preconceived issues and opinions whilst engaging critically with the data.

Once the researcher has processed the summaries and key words/phrases alongside their self-reflection in the Reflective Diary, the next stage is to group the words/phrases into themes. Each key word/phrase can appear in multiple themes and the process is repeated multiple times until all key words/phrases are assigned to a theme – note there is no upper or lower limit to the number of key words/phrases in a theme. When all themes are present and accounted for the final stage is to group common themes into overarching discourses.

4.0 Findings

Following the analysis, the Researcher found four overarching discourses and 13 sub-themes. these discourse are: Current Technology Usage; Disability, Health and Wellbeing; Social media; Expectations, Desires and Requirements of Technology at

University. Due to space limitations only Current usage, Social Media and Expectations, Desires and Requirements of Technology at University will be discussed. As is traditional with Foucauldian Discourse Analysis the Discourses drawn from Alix's words and her voice is paramount in this discussion [16] therefore this section will not focus on a traditional academic style of supporting or refuting with prior academic citations and will instead draw on, raise and explore Alix's voice. Whilst citations will appear it is not the focus of the work and a more academic discussion of the results can be found in the discussion section [19].

4.1 Current Technology Usage

Whilst other technology was mentioned the two main items that were a recurring theme within the data were phones and laptop; it is these items that Alix uses to engage with the world around her and her educative life.

Alix use of her phone can be described in the following quotes:

"*After waking up, I immediately check my phone for messages or important news, and systematically check it throughout the morning until I get to school."*

"I sometimes research topics on my phone… . I use... my phone... to watch educational videos"

"recreationally I use my phone more so it hold the most sentimental value to me."

For Alix the phone is not just a device for making phone calls, it fulfils three distinct roles - a social device, an educative device and a personal and sentimental device.

The phone features heavily as a social device and a personal and sentimental item, but where educative processes are concerned she mentions it very little or in conjunction with the laptop - *"I sometimes research topics on my phone"*. When looking at how Generation-Z wish to engage with learning material and educative tools there is a drive for mobile phone learning (for example include [20, 21]), (it is worth noting the use of the term mobile phone learning to delineate from the broader term M-learning and/or e-learning). The desire to use her phone for learning is not apparent in Alix' discourse, where educative technological use is discussed the focal point is her laptop.

The second aspect in Alix's current use of technology is her relationship with her laptop. Where the phone is a social, connected, immediate device the laptop is described in far more functional terms:

"My laptop is the most important as far as school is concerned"

The laptop in Alix's world is not a social device or an immediate access device, her use of the laptop is for a specific purpose and a specific task, as she explains here:

"I do a lot of school work on my laptop"

"I use my laptop to research and write essays, packages like excel to produce graphs and process data for science experiments."

Where the push with the Millennial generation was Web 2.0 [22] with a drive for laptop enhanced socially focused m-learning [23] it seems this approach needs careful thought with the next generation of students. Alix's social engagement is very much centred on her phone, the laptop becomes a processing device, there for writing, researching and creating. It is noticeable not once in the data does she discuss the laptop with regards to it being a social or socially connected device.

There is then a distinction between technological devices in Alix's world, the phone is a personal, sentimental, social and connected device, the laptop is a functional, practical, work-oriented tool. The way in which the two items are used are different and fulfil different roles:

"*My laptop is the most important as far as school is concerned, but recreationally I use my phone more so it hold the most sentimental value to me"*

For Alix the phone is an immediate and constant use device, it is there to connect to social media or current affairs. The phone is personal and sentimental – the phone holds a place of high value and high regard. By contrast the laptop is a functional device, it is used as a tool with a set purpose; unlike the phone there is no checking the laptop throughout the day. There are two streams - the immediate, connected and constant use of the phone and the functional, solid and fixed use of the laptop.

The devices used for education and recreation, as well as how they are viewed by the students with regards to educative purposes, need to be carefully reviewed with the newest generation of students,

4.2 Social Media

The role of social media within education was explored through a number of questions given to Alix, her responses are split into two sections; social media – positive/negative, and public/personal persona.

Interestingly when asked about universities engaging with students on social media Alix was fairly ambiguous.

"**J. How important is social media for educative purposes...**

(A) *Fairly important, it enables student to be able to ask questions without interrupting lectures"*

Interactions between students and their university via social media is less a chatty friendly relationship and more one of knowledge imparting. This said for Alix social

media is a complex and complicated tool, with both positive and negative attributes. There is no naivety as to the potential harm social media can do:

"What a person does online may impact their position in the university, online actions having consequences such as expulsion form their course."

Being connected to social media exposes those on the platforms to a number of risks in Alix's words:

"Personal social media can be used to maliciously attack students e.g. slut shaming, and because of how easily connected everyone is, gossip can spread very quickly."

However whilst being aware of the risks Alix takes an upbeat and optimistic view of social media, particularly social media for the wellbeing of students (and arguably society as a whole):

"It enables people to meet, new friends to be made, on a global scale. Information sharing across cultures improves understanding and tolerance. Social media can provide an escape for people who do not have anyone to talk to in their life, again fighting isolation. Being able to relate to someone is a powerful thing. People can stay in contact possibly enabling opportunities to become available in the future."

Existing on a virtual plain is given further complexity by the concept of an online persona. Alix writes in detail about the personal and public personas, their impact on academic life and how to manage two digital identities:

"A public university facing online presence is more important because the people who would be seeing this are academic peers and professors, how they perceive you could greatly impact your interactions in university and potential opportunities, for example helping with a professor's research. ...a personal online presence is still important because it allows you to be social with friends and family that you may not otherwise see..."

The personal persona and the public should not meet in Alix's eyes but they are uniquely and individually important – the personal for engaging with family and friends, the public for achieving potential career enhancement "*helping with a professor's research*". For Generation-Z it is not merely a case of crafting one virtual identity through social media but potentially multiple different identities and brands for any give role they wish to fill.

4.3 Expectations, Desires and Requirements of Technology at University

There were a number of discourses that became apparent that focused on expectations, desires and requirements of technology at university. One main discourse focused on what Alix required from university,

"PowerPoints which will be projected in lectures and used as a visual aid, all available online….lectures would be recorded and available online...."

"Interactive whiteboards would become standard, so diagrams drawn be teachers or students could be saved and added to PowerPoints. Wifi available in all parts of the school buildings, and the ability for teachers to wirelessly connect to the projector.... Verbal feedback on long homeworks or essays: teacher records feedback on app and student enters a passcode to access. More detail feedback can be given faster."

"patient contact simulations would be useful to practice procedures before trying in real life. Similarly, medical procedure simulations would be useful. Virtual models of the human body that can be manipulated by students, organs removed etc., to be used alongside real life dissection in anatomy lessons... they are still accessible online when the bodies are gone."

"minimum I would expect universities to provide PowerPoints online...."

The university built by Alix is not unrecognisable from the universities we inhabit as academics. There are a few key points to draw on, the access to feedback that is quick and personal and more indepth – there is no desire for contact time but the desire is for in-depth feedback. Virtual reality plays a big part through patient simulator and medical virtual labs which can again be used for individualistic self-research and self-driven learning. Alix's university is also interactive, there is WiFi throughout, PowerPoints are changeable and malleable in class by both lecturers and students and then sent to all involved. The university Alix envisions is not digitally remade but digitally enhanced.

Another aspect that Alix promoted throughout the text is the concept of inter-year group work and support:

"Medical student forums to facilitate information sharing between year groups would also be great as it reduces the work load."

"It can make building relationships with older students easier, potentially making the time at university less stressful and more enjoyable."

The collegial focus here is built on knowledge sharing and support, where older students can give advice to those younger undergraduates. This is knowledge-sharing and collaboration (remembering Seemiller and Grace [12], suggesting that Generation-Z were individually motivated), however the way this collaboration takes place is, in Alix's mind, on fora where students can asynchronously engage as they choose. Whilst not far removed from current VLE systems the key points here are that these are inter-year group and the drive is to share knowledge and lessen workload. It is not then a giant leap to see Alix's collaborative design as a free-form student-led PBL (Problem-Based Learning) model.

For Alix the student-led fora have a specific purpose to reduce workload, throughout her answer there are two key rationales for technology use – technology for time management and technology for ease of learning. Technology is not used for its own sake, it has to have a purpose. Alix repeatedly talks about using technology enhanced learning to ameliorate lecturers and students' use of time:

"the ability for teachers to wirelessly connect to the projector so less time is waisted with connectivity issues."

Technology here is viewed as way of ensuring "*less time is waisted*", the technology is a tool for enhancing traditional learning styles and methods – Alix talks of PowerPoints and projectors. This is not avant garde technological use but technology to enhance and ameliorate traditional learning. For Alix the use of technology should speed up the learning process and make knowledge acquisition easier.

Whilst technology enabled learning is a predominantly a positive experience and prospect for Alix, there is a theme running through the discourse surrounding the virtual versus real world experience, this becomes particularly clear when Alix discusses being a medical student:

"Students will study for exams using methods that help them to pass the technology aspect eg a simulation, while the real life procedure may be different and therefore less well learnt."

Whilst she is very positive about the role of simulations and digitally enhanced learning, there is still the desire for real world, real life experience. Furthermore she states outright that students risk studying for the simulation and potentially forgetting the complex and multifaceted variables of the real world making their learned experiences weaker. There is a balancing act between supporting students to engage with scenarios that are safe with the potential to make threat free errors from which to learn and cosseting them from unseen and unexpected real world variables.

Before moving to the discussion, it is worth briefly touching on the themes of technology that was viewed unhelpful:

"Some lessons use iPads to facilitate learning, but I think this is less effective because it can provide a distraction from the lesson."

This dislike of iPads in class is noteworthy as many countless hours of research have been done on introducing tablets to the classroom (for examples of such work see Mang and Wardley [24]). It is worth further research and discussion as to whether Alix's experiences are unique to her or more universal within her generation.

5.0 Discussion

Through Foucauldian Discourse Analysis a number of key discourses have become apparent in response to the research questions. The following section will explore both the original research questions and discussion points arising from the discourses drawn from the data.

Alix gives an insight into her educative future, which is not so far removed from the current situation. Notably, and once again drawing on the statement by Seemiller and Grace[12] that Generation-Z are individualistic in their learning, Alix talks about quick access to lecturers, optimised learning, clarification through videos which all point to self-driven learning. This then seems to be a point for further research: the methodology used to model the self-learning aspect of their courses. Whilst the themes of self-driven learning are self-evident Alix does also refer to collaboration through inter-year group fora, inter-year group learning is nothing new (the most obvious example being peer-to-peer learning as advocated by Vygotsky [25]) however it would be interesting to further explore to what extent Generation-Z whilst being individual learners wish to be individuals together. With this generation approaching higher education a revival of Problem-Based Learning and similar pedagogy could be appropriate.

The use of social media is an area that requires careful thought, however the direction of this thought should perhaps not be on how universities engage with students via social media but about how social media impacts students. Alix discusses the issues of being socially connected at all times and the repercussions of social media such as slut-shaming. Work has been done on the discourses around slut-shaming on campus [26] however universities must be prepared to adapt and develop their own internal systems for managing issues steaming from the virtual world.

Various ideas have been bounced around as a way of engaging and supporting this generation of digital natives (which in itself is a loaded and misnomic term) with their educative existence. With the arrival of Generation-Z into universities it is perhaps time to go back and review the older methods of imparting knowledge. I would argue that rather than a great technology enhanced paradigm shift achieved through technology we need a sideways shift with what is already there and available. Alix's responses do not talk of innovative or avant garde but of the traditional enhanced by technology: feedback apps, interactive PowerPoints, Fora.

There are limitations to this research; a single person case study is a well recognised methodological choice [27] allowing for in-depth analysis and deeper understanding, but by its singular nature the data cannot be extrapolated to a global level without due consideration. However it is a useful jumping off point to engage with further single discourse research – for example the question of phones versus laptops or the role of social media.

6.0 Conclusion

Alix's discourses are not to be taken as definitive nor should they be, however they do raise questions as to how higher education institutions view those coming to university in the next decade. Whilst it could be easy to once again be swept up in the concepts of paradigm shifts brought about by armies of digital natives, it would be better to review how Generation-Z themselves see their educative future, especially if they are to be a generation of individualistic learners. At the heart of the matter from Alix's discourse this generation needs efficient, digitally enhanced and interactive learning. However with all this in mind, this paper will close with a sobering reminder that not all technological support needs to have, to use a colloquial term, bells and whistles on it, some times a simple device will do or in Alix's words:

"**I. What do you think is the most important piece of technology for university?**

A recording device for lectures."

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The Cultural Impact of Accessible Gaming Mechanics: A Study Comparing Nepalese and UK Computing Students

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Abstract

There are more international students enrolled on UK university courses, studying abroad than international students studying in the UK. UK courses are increasingly being delivered overseas by partner institutions. Course designers are working to develop engaging material that adds value cross culturally. Applying gaming style elements to courses is a method that has proven successful in motivating and engaging students in a range of disciplines. This paper examines whether the benefits of employing game mechanics are reproduced in different learning and geographical cultures, as cultural influences on students' learning styles may be underestimated. This is achieved through a comparison of the engagement and success of students studying the same two modules delivered in the UK and in Nepal. The game elements applied have been selected for their transferability and capacity to equip course designers with accessible tools that focus on low risk participation, instant feedback and encouraging small increments of improvement through iteration. These particular components could be seen to parallel traditional learning cultures seen in Asian education.

Keywords: Cultural, game mechanics, engagement, performance, increments of improvement.

1.0 Introduction

Increased costs of a university education and reduced demand from traditional groups, means many universities are striving for alternative sources of funding. "There are almost 460,000 foreign students studying overseas for the awards of English HEIs" [1]. Universities are moving towards a different model with more diverse income streams. Forming global partnerships and franchises with other intuitions, both nationally and internationally is a developing trend. Education With Others (EWO) can provide an interesting insight into the impact cultural environments, languages and teaching styles have on engagement and performance [2].

Healey's [1] review of the Higher Education Statistics Agency (HESA) states that there are more international students enrolled on UK university courses studying abroad than in the UK. This paper reviews the behaviour of students on the same course, awarded by the same institution, delivered in different geographical and cultural locations. Four cohorts, from two continents are reviewed to determine if applying easily accessible gaming mechanics [3] impact on students' engagement with non-accessed academic content and assessment performance and how this is affected by cultural factors. This is achieved by recording the results of regular student engagement in self-reviewed challenges and their correlating assessment grades, comparing the achievements from cohorts in the UK and Nepal. The data reviewed has been collected from level 4 and 5 computing students.

The endeavours to encourage students to engage with non-assessed activities which could have a significant bearing on their academic achievement, is a subject which perpetually stimulates academic debate [4]. Traditional and innovative reward and penalty [5] approaches can be combined to motivate students to develop a deeper level of learning and consequently achieve a higher level of performance. Reframing traditional and reliable techniques to best reach students from different cultures allows us to build on existing best practices. The instant immediate world that UK millennials have grown up in, can provide us with insight into relating HE to a new breed of learners. The widely held belief [6] is that incorporating game play elements has positive impacts on engagement and performance. This is investigated to assess if it traverses learning cultures, whilst being mindful of stereotyping Asian students as surface or rote learners [7]. This study aims to propose a transferrable approach for implementing simple game mechanics that are effective in different cultural learning environments. Framing academic content in a gaming model [3] may prove more successful in particular environments and cultures.

Time pressed course designers and practitioners still strive to cultivate engaged, resilient students. Designing and implementing engaging, complex games however is difficult, time consuming, and costly [8]. Consequently, the aim is to apply accessible gaming principles using readily available tools, in a popular virtual learning environment (VLE). The focus is on low risk participation, checked not judged, instant feedback and small increments of improvement, achieved through iteration, to encourage a self-driven progress. These methods forgo the time

consuming elements of aesthetics [6], which may be more culturally specific, in favour of low effort, high impact, inclusive components. Although still time consuming to create, once written they can be deployed by anyone using the VLE, enabling tutors engaged in education with others to transfer the themes easily.

The goal of the research is to define an effective transferable approach for imbedding simple game mechanics into module content which can have a meaningful impact on all students' academic performance in assessments, regardless of cultural setting. Analysis of the results aligns to the research goal by providing measurable evidence to support effective international module development and structuring.

2.0 Methodology

2.1 Research Design and Approach

The research goals are achieved through quantitative analysis of students' performance in reference to engagement and attainment. The research primarily looks at trends and evidence from the numeric data collated from the VLE. The tools are designed to be relevant to module learning outcomes and the assessment strategy.

2.2 Research Methods for Data Collection

The Nepalese partnership with Northampton is well established and has been running in its current format for four years. The modules in Nepal mirror those in the UK, with very closely aligned content and identical assessments. The tutor in Nepal delivers both the level 4 and 5 modules. The authors of this paper wrote the modules and deliver them in the UK. The level 4 module is a prerequisite for the level 5, and must be passed before enrolling on the level 5 module. The four test groups were made up of 166 level 4 and 87 level 5 UK based computing students and 108 level 4 and 99 level 5 Nepal based computing students. One notable difference is the duration of face-to-face contact time in Nepal, who have three hours per week, compared to the UK who have two hours.

Data is collated from end of topic challenges, released online, along with other module resources, in advance of the end of term, time constrained assessment (TCA). Each challenge contains 10-20 questions reviewing the material covered in that topic. The questions include but are not limited to multiple choice, multiple answers, hots spots, code completion, matching, reordering and short answer style questions. Challenges are designed to test both knowledge and understanding, not just memory. This facilitates comparison of "cultural differences between Western and Asian conceptualisations of memorising" [9] and the practice of 'memorising with understanding'.

The challenges are marked literally by the VLE with regular expressions allowing for variations in free text answers and are scored based on correctness and good practice. They are designed to provide instant feedback [6] relating to performance

on each question (a score). To discourage passive learning, they purposefully do not reveal the solution, how to improve the outcome, or where any errors were made. They are written to simulate key components of assessment requirements and address the learning outcomes of the module.

The same six, end of topic, online challenges were completed by both level 4 cohorts and the same ten challenges completed at level 5. Level 4 students are directed to complete the challenges and given time at the end of a face-to-face class to attempt the challenges. Nepal level 5 students are treated the same as level 4 students. The UK level 5 students were encouraged to complete the challenges in their own time and only those who completed the timetabled practical activities asked to attempt the challenge in class. All cohorts are encouraged to repeat the challenges frequently to improve their results, adhering to the concept that gamifying rewards effort, not winning [10]. Students can start a test and return to it later, these are categorised as 'In Progress'. At the point of collecting the data the 'In Progress' tests were manually submitted by the tutor. The results from the challenges were collected using the highest mark achieved by the student across all their attempts on a challenge, as a percentage. The results from each cohort are collected in terms of:

- The proportion of the cohort attempting the challenges (engagement)
- The proportion of pass marks (>40%) by cohort in the challenges (achievement)
- The level attained by the cohort in challenges (performance)

At the end of the first term, all cohorts sat a TCA compiled of 35 - 45 questions in the same format as the challenges and marked in accordance with the original process. For ease of comparison the TCA results were collected as a percentage, rather than a grade. Grades have also been used for comparisons but simplified to the absolute grade; A >= 70%, B >= 60%, C >= 50%, D >= 40%, F > 0% and non-submissions categorised as G. Results from each cohort are collected in terms of:

- Proportion of cohort attempting the TCA (engagement)
- Proportion of pass marks (>40%) by cohort in the TCA (achievement)
- Level attained by the cohort in the TCA (performance)

The results from the challenges are correlated with those of the TCA. The results are cross referenced and analysed as follows:

- Comparison of challenge engagement with TCA engagement by cohort
- Comparison of challenge achievement (pass/fail) with TCA achievement by cohort
- Comparison of challenge performance (grade) with TCA performance by cohort

2.3 Justification of Research Approach

The cohort sizes for computing students at the University of Northampton and the partnership with Nepal facilitate good datasets. The structure and straightforward approach allows for a clear and measurable comparison of results. The modules delivered to each cohort are reviewed and validated based on the University's procedures and ensure a consistent level of assessment. The consistency in academic content, assessment and tutors, helps to preserve comparability in the two cultural environments, affording additional reliability in the results.

3.0 Results

The datasets from Nepal and the UK are 108 and 166 student cohorts respectively for level 4 and 99 and 87 for level 5, a combined dataset of 460 students.

3.1 Challenges

Table 1: The percentage of cohort completing all challenges

	Level 4	**Level 5**
Nepal	75%	73%
UK	65%	36%

Table 1 shows that Nepal has a notably higher engagement with the challenges than the UK, particularly at level 5. Nepalese students were 10% more likely to complete all the challenges at level 4 and nearly 40% more likely to complete all the challenges at level 5. 25% and 27% of Nepalese students and 35% and 64% of UK students are not engaging fully with non-assessed content.

Table 2: The percentage of cohort who passed the challenges on average

	Level 4	**Level 5**
Nepal	93%	86%
UK	77%	49%

There was a marked difference in those achieving an average of over 40% in the challenges, as shown in table 2. At level 4 Nepal have a 16% higher pass rate in the challenges than the UK cohort. At level 4 only 7% of the Nepal cohort failed the challenges on average compared to 23% of UK students. This is more apparent at level 5 where although pass rates are lower in Nepal than level 4 they are 37% higher than their UK counter parts.

Table 3: The percentage spread of grades achieved by each cohort in challenges

Level	**4**	**5**	**4**	**5**	**4**	**5**	**4**	**5**	**4**	**5**	**4**	**5**
%	**A**	**A**	**B**	**B**	**C**	**C**	**D**	**D**	**F**	**F**	**G**	**G**
Nepal	76	74	7	6	5	3	4	3	7	13	1	1
UK	27	25	12	6	15	9	13	9	25	31	8	20

At level 4 and 5 roughly ¾ of all students in Nepal achieved an A grade in the challenges, compared to just over a ¼ of level 4 and 5 UK students (table 3). Nepal and the UK saw a 6% increase in fail grades from level 4 to level 5. However, at level 4 only 7% of the Nepalese students failed the challenges overall, whereas 25% of UK students attempted and failed the challenges. There is also an obvious disparity in the number of G grades at level 5, which is 19% higher in the UK than Nepal, this is smaller at level 4 with a 7% gap.

3.2 TCA

Tables 4: The percentage of cohort attempting the TCA

	Level 4	**Level 5**
Nepal	99%	100%
UK	96%	92%

The percentage of students attempting the TCA shown in table 4, are high for all cohorts. Nepal have very low levels of non-engagement with assessments, with 100% engagement by level 5. The UK non-engagement grades for the TCA are higher than Nepal, showing 3% and 8% fewer attending but still represents a good engagement with the assessment.

Table 5: The percentage of each cohort passing the TCA on average

	Level 4	**Level 5**
Nepal	94%	96%
UK	67%	76%

Table 5 shows that Nepal has a very high and consistent basic pass rate, between 20% and 27% higher than the UK.

Table 6: The percentage spread of TCA grades achieved by each cohort

Level	4	5	4	5	4	5	4	5	4	5	4	5
%	A	A	B	B	C	C	D	D	F	F	G	G
Nepal	27	78	27	13	25	1	15	4	6	4	1	0
UK	55	32	12	17	5	15	5	11	19	16	4	8

Table 6 shows that at level 4 the percentage of students achieving an A grade in the TCA in the UK is almost double that of the Nepalese students. Conversely, at level 5 it is 46% higher for Nepal. At level 4 the difference in performance is reduced when considering students receiving 'good grades' (A+B grades). All cohorts achieve 50% or more good grades in the TCA. At level 4 the UK good grades are more than 10% higher than Nepal but at level 5, Nepal have almost double the amount of A+B grades.

3.3 Relationship between challenges and TCA

Table 7: Correlation between average challenge and TCA results

	Level 4	Level 5
Nepal	0.44	0.58
UK	0.73	0.62

The Nepal cohort has moderate correlation between the performance in the challenges and the TCA, which is slightly higher at level 5. This is illustrated in table 7. The UK shows a strong correlation which is higher at level 4.

3.4 Attendance

In Nepal most of the students have above 70% attendance. 63% of UK level 4 students attend 70% or more of the time but a level 5 it dropped to 37%.

4.0 Discussion

4.1 Engagement

The Nepalese cohort displayed high engagement with the non-assessed academic content (table 1), demonstrating approximately ¾ of all students completing all the challenges at level 4 and 5. Nepal are more likely to complete all the challenges than the UK students. The distinction in engagement may be due to cultural differences in teaching and learning styles. The additional focus on face-to-face contact in the

Nepalese institution, enables time to be dedicated to engaging with the challenges. Although taken from a study on the Indian education system, Gopalan [11] noted a huge reliance on examination scores as a measure of success which predominantly fuels motivation. Similarly, less value is given to critical thinking skills and self-learning.

It is interesting to note how the same challenges could be presented as either game play or exam rote, as a means of engaging various learning cultures. If Giridharadas's [12] observations of Indian education are widespread in Asia, rote memorization remains the standard pedagogy, which could account for the levels of engagement, congruent of the teaching style. Raymond's [13] research found that Asian students tend to be dependent learners relying on their teachers but also noted that Asian students are less hesitant to ask questions in class. This, coupled with perseverance being rated as a virtue [13] in Asia, would provide explanations for the increased engagement with the challenges, over the UK students, rather than any intrinsic motivation [10] provoked by gamification.

In uncertainty avoidance cultures seen in Asia, engaging with preparatory activities may be seen as a way of minimising uncertainty in the TCA. At level 4 both Nepal and UK students are given time to complete challenges in class. Level 5 UK students are encouraged to complete challenges in their own time, which clearly has a significant impact on engagement (table 1). At level 4, 25-33% of students are not engaging fully with non-assessed content but at level 5 this is close to a staggering 2/3 in the UK. It is disappointing that students are not completing all the challenges, particularly where cohorts are explicitly directed to complete the challenges and given time in class, which is more restricted in the UK institution. However, this may provide some indication of other significant factors specifically attendance. Although not part of this study directly it is reasonable to assume that attendance has an impact on engagement with academic content and consequently achievement. The Nepalese tutor reported good attendance with most students achieving over 70% attendance, whereas only around 40% of students achieved this in the UK level 5 cohort. There is evidence to suggest that the level 5 cohort attendance is uncharacteristically low for that module, the same cohort had low attendance in the level 4 module the previous year. Attendance for the level 4 UK students showed that about 65% of students were attending more than 70% of the time. It could be inferred from this that engagement with the activities is related to attendance and derived from that, the requirement of having to do them in class, not the gaming components, that is eliciting the improvements.

It is commonly accepted that students are less likely to engage with content that is not assessed [14]. It is therefore reasonable to expect, the percentage of students engaging in the TCA is higher with all the cohorts, than engagement with content. Nepal demonstrate very low levels of non-engagement with assessments (1%) see table 4. The cultural research suggested [11] that worth was gained from achievement in exams, and in order to succeed, you have to attend, which could prompt the exceptionally high level of engagement with the TCA in Nepal. The

engagement with the TCA relative to the challenges is consistent in all cohorts. As with the challenges, in the UK non-engagement grades for the TCA are higher than the Nepalese students, but still represent a strong engagement with the assessment.

4.2 Achievement

Overall, the level of achievement (scoring on average above 40%) in the challenges is higher than the level of engagement. This suggests that a proportion of students are passing the challenges on average despite not completing them all, consequently achieving significantly higher grades when they do engage.

Nepal's 10% higher rate of engagement with content (table 1) returns a 15% higher pass rate with the challenges (table 2) and a significant 30% higher pass rate in the TCA (table 5) than the basic pass rate in the UK TCA at level 4. At level 5 a 40% increase in engagement with the challenges in Nepal converted to an almost equivalent improvement in achievement with an 86% pass rate in the challenges and a further 10% increase in pass rate in the TCA. This represents a meaningful difference. The same content and assessment are delivered which indicates that even small increments of improved engagement in academic content can have a valuable effect on results. Causality is not clear, but it can be inferred that cultural differences may have impacted on achievement levels. If the cultural differences in conceptualising memory [9] are considered for Nepal, progressing from level 4, where they achieved well and applied memory with understanding would provide a solid grounding [15] for the level 5 module.

4.3 Performance

The majority of students in Nepal achieve a top grade overall in the challenges at level 4 and 5 with ¾ of all students in the Nepalese cohort achieving an A grade, compared to roughly ¼ of UK students (see table 3). Conversely the percentage of students achieving an A grade in the TCA is much higher in the UK level 4 cohort when compared to the Nepal cohort (see table 6). At level 4 the UK TCA A grades are almost double that of the Nepal cohort. The difference in performance is reduced when considering students receiving 'good grades' (A+B grades). Although both level 4 cohorts achieved over 50% good grades in the TCA, the UK still has a 13% higher rate of good grades. However, at level 5 Nepal considerably exceeds their level 4 performance and the UK, with a striking 78% achieving A grades. The cultural preference to "seek understanding through the deep approach" [15] which underpins 'memorising with understanding' might be a contributing factor of the Nepalese students' improvement in the second year.

The performance in the Nepal level 4 cohort is considerably higher in the challenges than in the TCA for "good" grades and fails. This may be explained by cultural learning and language differences. The TCA by definition, is time constrained. The greater success in the challenges over the TCA could be a consequence of traditional learning styles. Tutor led contact time is more valued in Nepal than the UK and therefore students are given time, and encouraged to, repeat the challenges during

class. This may result in some levels of 'knowing' the answers to the exact question rather than understanding them. Consequently, at level 4 when it comes to the TCA Nepal are unable to apply their skills, beyond the basics. However, this appears to change as students progress into level 5, where they demonstrate development as learners and apply knowledge and understanding to succeed in the challenges and assessment. At level 5 in Nepal, 78% of all students achieved an A grade and 91% achieved good grades (see table 6). It is interesting to see that the level 5 Nepal cohort appear to have learnt from their mistakes in level 4 and improved their application skills, to apply their challenge experiences to the TCA assessments.

The UK sees general improvement in achievement and performance from challenges to TCA grades at level 4 and 5. 28% improvement in good grades and a 6% reduction in fails, despite the 4% reduction in G grades for level 4 and 11% improvement in good grades at level 5 (see table 6). However, both these improvements impacted on the pass grades (C+D). Oddly at level 4 the change in C+D grades is the opposite in the UK to Nepal, with a notable drop in pass grades from challenges to TCA in the UK. The improvement in TCA grades in the UK level 4 and 5 may be attributable to increased level of engagement in the TCA compared to the challenges.

5.0 Conclusions

There is a good correlation between the performance in the challenges in the UK and their performance in the TCA at both level 4 and 5. It is notable that although there is moderate to good correlation in Nepal, the strong correlation seen in the UK between challenge and TCA performance is not as significant in Nepal, even though the content and approaches are the same. This is interesting, but it does not show causality.

The cultural research [7, 9, 11, 13, 15] suggests that the style of the assessment has an impact on the way students revise and learn from it. It proposes that students adapt their learning styles in response to the assessment demands. The nature of these challenges and TCAs may lend themselves to promoting success for students who incorporate 'memorising with understanding' in their learning style, and those students familiar with this process are more successful.

The findings suggest that adding gaming mechanics to courses is a successful way to engage students and improve performance across cultures. It is likely that they are successful in the Nepalese cohorts due to their parity with traditionally accepted and preferred learning styles rather than their inherent gaming nature. Proposed strategies for engaging Asian learners [13] recommend the use of prompt feedback and review, both of which are core components of gamification. This suggests a natural allegiance between some gaming mechanics and cultural learning styles dominant in Asia. At its core, gamification is underpinned by repetition and mimics rote learning, affording instant feedback and small increments of improvement through iteration.

6.0 Impact

At a practical level the research has developed simple and structured challenges, that work in different cultures for ostensibly different reasons. The challenges form stepping stones which provide a clear line of sight between module content and assessments and have been shown to support students in their corresponding assessment, irrespective of culture. This is achieved using accessible, transferable tools to provide maximum return on effort for tutors designing EWO and local content. Consideration is given to the motivational influences of student participation with the challenges either from gaming or the need to succeed. It is also noted that engagement is clearly impacted by requirements in class and the corresponding impact of increased contact time on the outcomes. Although educators strive for independent students, we can notably improve their performance in exam style assessments by explicitly directing their preparatory efforts.

7.0 Further Study

This paper forms the foundation for a body of research looking at the application of game mechanics. The next stage is to incorporate the results of the problem-based assessment which requires greater independence of thought and higher levels of critical thinking. Additional gaming tools such as badges and leader boards will also be implemented to consider their impact on engagement and performance.

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Creating a Syllabus for Cyber Security Careers and Employability

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Abstract

This paper provides an outline of a syllabus on cyber security careers and employability developed to run alongside an MSc in Information Security. The syllabus exposes the students to a variety of content that can help them put the taught elements of the MSc programme into the careers context and helps them make better decisions around their degree contents and potential career pathways. A variety of elements that can aid the student are discussed and some initial student feedback presented.

Keywords: cyber security, careers, employability, syllabus

1.0 Introduction and Background

Employability and careers have been integrated into the university diet for many years, typically with a focus on soft skills development, and a variety of workshops offered by the careers service. Context is typically given at the school/department as subject matter experts alongside speakers and events from industry partners. The development of a year in industry programme for the Royal Holloway MSc in Information Security was a catalyst/driver for the development of additional learning components and a cyber security employability and careers syllabus. This paper discusses the key elements of a cyber security careers and employability syllabus and reports some feedback from students on the initial version of the syllabus.

The context around this syllabus are the developments in the cyber/information security discipline and the profession both in the UK and worldwide. The syllabus for cybersecurity careers is based on a number of recent developments from government, industry and academia. These developments in the UK have included:

- the funding of the CyBOK – Cyber Security Body of Knowledge [1] to provide a basis for the profession,
- a proposal to create an overarching chartered body, the "UK Cyber Security Council" for developing the cyber security profession [2],

- certification of undergraduate and postgraduate degrees in cyber security [3] which use the Institute of Information Security Professionals (IISP) skills framework as a basis for certification [4],
- cyber careers initiatives from industry such as Inspired Careers [5], and
- the inclusion of more security roles within the SFIAplus framework [6] that helps students to understand the scope of certain cyber security roles.

On the worldwide stage the ACM created a joint task force on cyber security education [7] to define the discipline and an undergraduate curriculum [8] which provided outputs in the period 2016-18. Alongside this the work of NIST (National Institute of Standards and Technology) has developed NICE (National Initiative for Cybersecurity Education) [9] and their cybersecurity workforce framework [10]. In the US, there is additional careers materials and opportunities provided by Cyber Seek [10] which provides material on careers pathways as well as a heat map of cyber security supply and demand. The Cyber Seek pathway information provides information on job titles, certifications and is based on the NIST NICE cybersecurity workforce framework [11]. The US Department of Homeland Security also provides additional information on education and workforce development [12].

These developments and resources provide an exciting opportunity to engage students more comprehensively with cyber security careers as well as the wider scope of the discipline. At Royal Holloway the author has been developing a cyber security careers curriculum primarily for the students on the MSc in Information Security with the year in industry pathway. Additionally, this led to the development of a Coursera MOOC (Information Security: Context and Introduction) in late 2016-early 2017, which provides a wider exposure to several of the core concepts outside. of the MSc programme itself.

The cyber security employability and careers curriculum developed consists of the following components:

1. Discussion of the cyber security curriculum based on the CyBOK and the work of the ACM Joint Task Force on Cyber Security Education,
2. The development of the profession through a discussion on the variety of professional bodies, their certifications, code of practice and ethical issues,
3. Developing knowledge and understanding of cyber security roles, skills, knowledge and career pathways based on a combination of US work from NIST, SFIAplus and an industry model. The industry model discusses the vendors/suppliers and the consumers as various market verticals which can be used as a basis for discussion and characterisation of roles and careers,
4. Integration of the careers service for several workshops and CeDAS [13] who provide a specific module on numeracy and psychometric testing,
5. Engaging with representatives of the industry through a seminar series and a specialist careers fair.

The paper discusses some of the pedagogic basis in section 2, the content, structure and assessment in section 3 and section 4 provides some initial student feedback on the curriculum presented.

2.0 Pedagogic Model

The spiral curriculum model of learning was proposed by Jerome Bruner [14] and basically the curriculum develops by revisiting and building on foundational ideas and knowledge. There are often a number of rotations through the spiral that provide:

- ***Reinforcement*** – through a continuing exposure to topics, so that students are continually looking back on topics covered.
- ***A move from simple to complex*** – provided in a controlled way so that the student can master the subject. The student builds new knowledge on old knowledge – exploring topics at different levels.
- ***Integration*** – rather than a series of courses/topics that are often compartmentalized, the spiral should break through the boundaries,
- ***Logical sequence*** – the spiral model should enhance the sequence of learning.
- ***Higher level objectives*** – a spiral curriculum should build the application of knowledge and skills.
- ***Flexibility*** – the students can transfer to upper levels of the spiral.

Our MSc in Information Security structure is a standard UK 180 credit (90 European Credit Transfer and Accumulation System (ECTS) credits) delivered in a one-year full time format, or over 2 to 5 years in part time study modes. It is based on a core set of four modules (aka courses) that cover a breadth of essential knowledge and skills as the basis of information security, taken by full time students in term 1. There are two streams the first (core A) is more technical, the second (core B) is still technical but has a more business focus:

- Core A consists of security management, applications of cryptography and security mechanisms, network and computer security.
- Core B consists of security management, applications of cryptography and security mechanisms, security technologies (a cut down version of Network and Computer Security) and Secure Business Architectures.

In term 2 the student deepens their knowledge through application of the core knowledge through several optional modules and selecting and starting their individual dissertation project. The optional modules allow the student to gain knowledge and skills in areas such as security testing (penetration testing), secure software, digital forensics, cybercrime, human aspect, law and e-commerce, embedded systems/Internet of Things and critical infrastructure/SCADA.

The MSc then splits into two pathways; either the student completes a 60-credit dissertation project, or the student undertakes a one-year placement. In the year in industry pathway, the student finds a placement in the industry for between 9 and 12 months and returns to complete the dissertation the following summer.

This is akin to a basic spiral implementation represented in Figure 1. However, the MSc is compressed into one year in its standard form or into two years when it includes a one-year placement in the cyber security industry. The spiral is thus quite compressed in comparison to the many years typically considered in the spiral curriculum model. When considering the spiral curriculum, in the context of cyber security education, one could consider including the individual's professional development after graduating. This would include additional development of knowledge and skills through professional practice alongside membership of a professional body and associated certifications. The extended spiral model considerations though are outside the scope of what can be consider in this paper. Our focus is to link cyber security careers and employability in a parallel spiral alongside the core MSc curriculum.

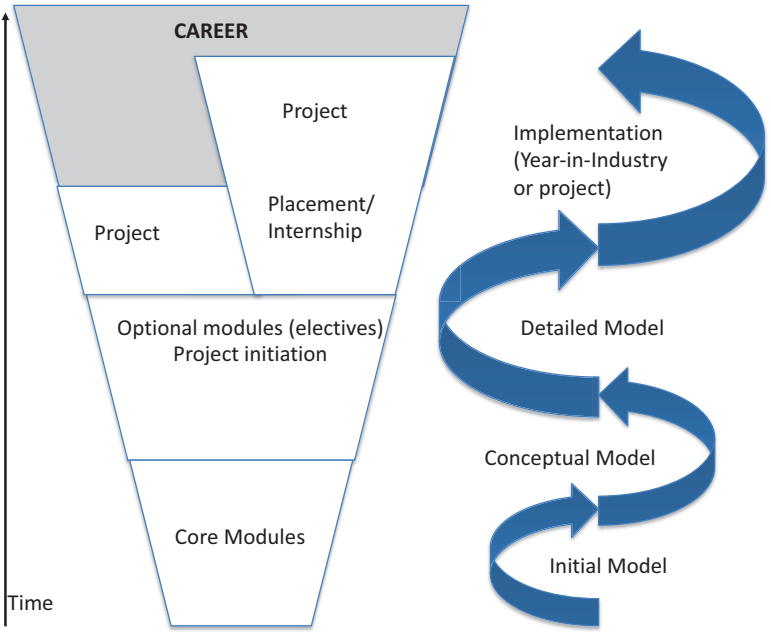

Figure 1 Spiral representation of the MSc Information Security

Whilst the student undertakes core A or B, then optional modules and starts the dissertation project, the cyber security careers and employability syllabus is delivered in parallel. Figure 2 provides a representation of this in the spiral form. To the left of the spiral there are a number of assessment and practice elements and to the right delivery of materials. These are discussed further in section 3.

3.0 Content, Structure and Assessment

The syllabus is designed to sit alongside the course contents in the first term. Initially the students are introduced to the concepts, then they engage in careers workshops, content around the knowledge areas, specific cyber security careers content, professionalisation of the industry, a model of the industry, culminating in the specialist careers fair. The predominant engagement after the fair is a series of talks from industry speakers that continues through into the second term.

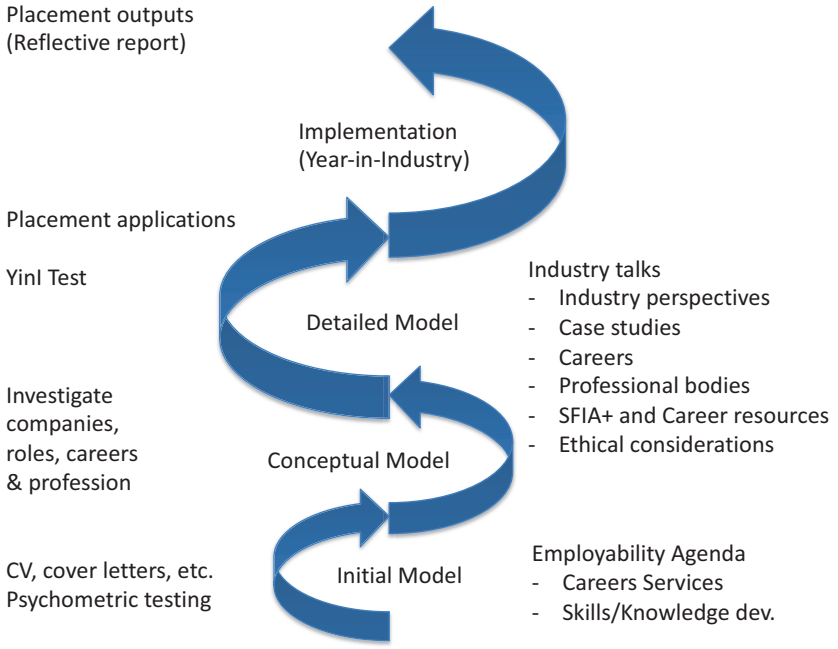

Figure 2. Spiral representation of Cyber Security Careers & Employability syllabus

The introduction provides the students a roadmap to the year, whether on the year in industry track or a standard one-year MSc. The students are engaged with the ACM Joint Task Force 9 knowledge areas (KA) and the CyBOK 19 KAs described in the CyBOK scope document which outlines these areas in 5 clusters [15]. The scope document provides a succinct description of the 19 KAs in the 5 themes:

- Human, Organisational and Regulatory Aspects
- Attacks and Defences
- System Security
- Software and Platform Security
- Infrastructure Security

The CyBOK project is expected to have a separate document that discusses each KA in detail by the summer of 2019. However, at the time of developing this syllabus the detailed documents were not available, however the CyBOK scope document

provides a good overview. The students are asked to undertake a formative assessment at this point where they look at the MSc and map course content to KAs. Later the students are asked to consider the mapping of key KAs to cyber security roles/skills.

The implementation discussed in this paper then provide a mix of careers and skills workshops with the introduction to the cyber security specific content. The elements provided by the careers service include: a CV workshop including the development of a LinkedIn profile, an application forms workshop, an assessment centre workshop, an interview workshop, and lastly a numeracy testing and psychometric testing workshop. Here the key formative assessment is for the students to write/rewrite their CV and they are encouraged to attend optional 1:1 interview practice and undertake numeracy and psychometric tests.

Parallel sessions run alongside the careers elements above to provide the specific discussion on cyber security careers, jobs and roles. The first element is to look at the less formal information contained in the careers websites. For the UK the students are particularly directed to the Inspired Careers content [5] and the US Cyber Seek [10] content. This allows a discussion of a number of different roles and career pathways. The content at Cyber Seek is particularly of interest as it is linked to the data on cyber security job adverts and provides an analysis of the employer demand and the certifications requested. The students are then introduced to a more formal analysis using SFIAplus, and the NIST NICE materials. These provide a clarification and reinforcement to the Inspired Careers and Cyber Seek information. In general, most students prefer the less formal information provided by Inspired Careers and Cyber Seek. The students are encouraged to consider the KAs particularly pertinent to the various roles/jobs, the aim is to help them decide on the options that they will take in term 2.

The students are then introduced to the professional bodies in cyber security with an overview of the bodies that are active in the UK, alongside their typical activities. A thread on the virtual learning platform provides information on some of the events that take place locally. Several professional bodies give talks as part of the industry seminars to provide more depth and provide their perspective on cyber security professionalisation. In this context there is a brief discussion to introduce the professional code of conduct and ethics although, generally these aspects are covered in the core modules as they arise, for example in penetration testing etc. The students are enrolled as student members of the IISP for the duration of the MSc.

The students are then introduced to the cyber security industry through presentation and discussion based on the application of the producer-consumer model to the cyber security industry. Here the students consider the range of cyber producers and the variety of consumers using a well-established industry model that considers the various market verticals that exist. The cyber security industry model also builds in the concept of regulators etc. (termed enforcers) and the adversary. The aim is to consider these categories as the industry speakers present their perspectives on the industry, their company/organisation and the challenges they face.

As the students complete the majority of the careers and employability contents there is a specialist careers fair jointly held with the Computer Science Department. This is aimed at bringing employers to the students for both permanent roles (typically graduate schemes) and for placements. The industry seminar series then begins in earnest with weekly talks from one or more industry speakers on a variety of topics. Some are related to bringing the potential employer to the attention of the students and others are more specific to a market vertical or a technology. The term 1 content is then tested for those students wishing to progress to the year in industry option. The culmination for those students taking a year placement is then a reflective report on their work experience.

3.1 Internationalisation Factors

Jude Carroll, in chapter 8 of her book, Designing programmes and courses with an international perspective, pp. 101 – 117, provides a discussion on the internationalisation of the curriculum [16]. As cyber/information security is a global problem and needs international solutions there is an international flavor that can be applied. For example, by the wide use of international case studies. With a large number of international students on courses in the UK the provision of these is a highly desirable aspect.

However, the scope of cyber/information security is wide. Using the Becher and Trowler taxonomy [17] the scope of the discipline can be identifies as ranging from hard (mathematics, computer science, physics), through hard applied (ICT, engineering) and into the soft applied subjects (law, psychology, sociology, business, economics etc.). Covering all aspects with an international perspective would, in general be too onerous. For example, trying to deal with multiple legal systems within a cybercrime or penetration-testing module would be challenging.

Internationalisation in the context of the syllabus and the cyber/information security industry consists of the aspects, taken from the Centre for Curriculum Internationalisation (CCI) based at Oxford Brookes University [18]. The following fit into the context of the MSc programme:

- Ethics in a global context, such as consideration of code of ethics/conduct from various professional bodies, at the moment these are limited to US and UK based organisations.
- Provide a historical and multicultural background to current practices, such as the differences seen in various geographical areas or markets [19]. For example, in Japan the majority of cyber security and ICT jobs are currently in systems integrators and service providers as 75.2% of IT functions are provided as a service and 24.8% are provided in-house. In the US the opposite is seen, where 71.5% are in-house and just 28.5% are outsourced.
- Ask students to reflect on learning and work experience/opportunities in the context of their own culture and the industry players in their home country. This includes the professional bodies that they could engage and certifications that may be appropriate depending on their country or region.

The example above, comparing US and Japan for in-house vs. outsourced ICT indicates a different job market dynamic between these two areas. This requires a student to prioritise different market players when engaging in different countries and also importantly consider appropriate professional bodies and certifications. The industry and careers component can be used as one tool to exemplify the internationalization aspects within the curriculum. In this context the students are introduced to the Frost and Sullivan Cyber Security Workforce Surveys [20]. These are sponsored by the Centre for Cyber Safety and Education and $(ISC)^2$ and cover Europe, North America, Latin America and Asia/Pacific as well as reports on the multicultural nature of the cyber security workforce and women in cyber security.

4.0 Student Feedback and Further Work

Initial feedback from students based on a binary scale (a positive or negative to the content) found the proposed syllabus useful, although the student engagement in formative assessment is not as high as hoped for. However, the analysis of positive and negative sentiment shown in Figure 3 indicates some success for the syllabus.

Of the five components to the proposed cyber security employability and careers syllabus, the students particularly value the discussion on knowledge areas, NIST NICE and SFIAplus as well as the discussion on professional bodies and ethics. All areas of the syllabus received overall positive feedback with the material around roles and careers having the largest negative sentiment. Based on student comments this was largely because there was too much material on UK roles and careers and with over half the full-time campus cohort from overseas, additional international content would be valued.

Further evaluation is required to determine how useful this proposed syllabus is in providing linkage and better understanding between the core academic materials covered in the MSc and developing the student engagement and understanding of the cyber/information security industry. More detailed student measurements are required to understand the key elements that are most useful and engaging and how well this engages the students in their understanding of cyber security.

As always, the cyber security industry, the professional landscape and the curriculum do not stand still. The key UK changes expected in 2019 and 2020 are around completion of the first edition of the CyBOK knowledge areas and the development on the professional landscape. Additionally, the SFIAplus framework is to include additional roles based on the NIST NICE framework to provide greater harmonisation. Further afield, the syllabus discussed here can be extended for the larger European context.

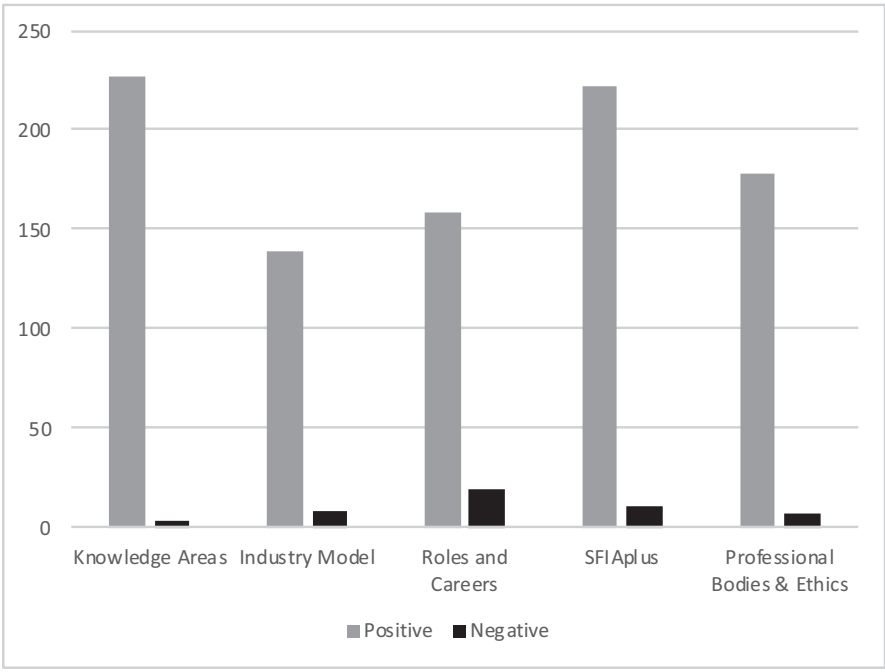

Figure 3: Student feedback on syllabus elements

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Digital Learning Challenges and Innovations for Sustainable Education in Developing Countries: Issues of Policy and Practice

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Abstract

Social Innovation (SI) as well as digitally developed SI are playing a critical role globally in solving complex contemporary social challenges and are gaining popularity in developing countries. This study defines SI as the development and delivery of new ideas and solutions (products, services, models, markets, processes) at different socio-structural levels that intentionally seek to change power relations and improve human capabilities as well as the processes by which these solutions are executed. SI has become influential in practice, scholarship and policy as the conceptual basis for organisations, from grassroots movements to Social Development Goals (SDGs) and the European Union strategy. In developing countries such as Kenya, SI come in many guises, at the core of which lies the application of digital solutions to resolve emerging social problems. The application of digitised solutions requires the development of ICT literacy in the form of e- learning so as to enable the development of 21st century skills. Discourses on ICT integrating in development has been going on for over 30 years and with this comes the need for applicable and sustainable e-learning targeted at various groups.

Using archival data, this paper considers new contemporary challenges and the need to develop 21st century competencies. It will investigate digital learning challenges and innovations in developing countries in general but with a focus on Kenya. It will examine policies that facilitate and implement best practice.

Significant for this study is that digital SI acts to support and (a) improves welfare and therefore human capabilities and that SI including development ICTs (b) reaches its target only if the most vulnerable in the population are affected and integrated. The topics of technology use in education in particular and SI in general are popular in practice but there is limited research on their impact, an area this paper will contribute to. There is rapid growth of ICTs and therefore published works on this topic in numerous disciplinary fields. Therefore, as opposed to full reviews, this paper offers a broad overview in some areas and where possible and applicable examples to illustrate themes and arguments. A thorough examination of the data concludes that there are common themes regarding ICT integration which have persisted overtime. Consequently, among other solutions, theories that delve further than access as barriers such as the Capability Approach as well as transdisciplinary collaborations are the solution to enabling sustainable digital learning.

Keywords:ICT policy, e-learning, digital learning, education, developing countries

1.0 Introduction

The ideas of ICTs ubiquity, availability and widespread use is common knowledge but despite this, questions still exist as to what extent it is contributing to development especially for the targeted poor [1]. Articles by Walsham and Sahay [2],Avgerou [3] and Heeks[4] all indicate that the general discourses regarding ICTs include (a) technology and knowledge transfer, (b) a process of socially embedded action and (c) transformative interventions. These topics were popular then and still are the most prevalent and will be explored as they affect ICT integration today. This is evidenced in literature surveys by Gallivan [5] and in the setting of future agenda for the field article by Heeks [6].

Technology integration is pedagogically important as it enhances the learning environment in a creative way to transform the education landscape [7]. Examples include the One laptop Per Child (OLPC) initiative introduced by a couple of United States Non-Profit organisations. Basic XO laptops costing $100 were offered to provide a multimedia, collaborative user interface with educational software in a bid to cover large populations. Other countries adopted the idea, for example in 2001, Thailand rolled out the One Tablet Per Child (OTPC) programme by issuing 800,000 units and later increased by a further 2 million. Other countries that took similar paths include Peru, Uruguay, Mexico, Ethiopia, Cambodia, Brazil and India [4]. There are other informal experiments-based projects including the Minimally Invasive Education (MIE) [8]. This is a hole in the wall experiment which illustrated that ICT enhanced learning in children between 8-14 years of age. This was achieved through discovery, exploration and peer coaching with minimal invasion. Another such experiment is the Worldreader project where e-readers are

preloaded with e-books and distributed to school libraries in developing counties for children to access [9]. This on evaluation demonstrated improvement in reading proficiency as well as interest in literature. Studies in Thailand demonstrated that student learning had improved [10]. Studies which explore the role that education plays in promoting economic growth corroborate the importance of cognitive skills of a populace as fundamental to sustainable development [10]. This is also corroborated in studies that relate skills development and growth as well as the role scientific literacy plays in eliminating social obstacles that hinder progress to democratic and humane societies [10].

Against this backdrop, this paper is organised as follows. The next section looks at ICT and policy in the developing country contexts using Kenya as an example. This is followed by an outline of why ICT Integration is deemed important. It then investigates any learning that can be applied to enable transformations and change in ICT integration considering criticisms of past efforts and then explores and outlines ideas for solutions. Finally, it concludes by providing an overview of challenges as well as criticisms that will pave the way towards more successes in integration.

2.0 ICT in Low Income Countries

The growing inequality in Kenya is a situation that is reflected when it comes not only to access to education in general but also when it comes to digital integration and e-learning. This is contributing to the digital divide. The digital divide refers to the gap between the digitally literate and those that are unexposed and/or illiterate [11]. Brandtzæg et al. [11], class internet users as non-users, sporadic users, instrumental users, entertainment users, and advanced users. Within these categories, non-users and sporadic users form the digital divide [12]. This disparity in access to ICTs limits the effectiveness of national innovation systems claimWiseman and Anderson [13]. Most ICT literature places the role of integrating ICT execution as mainly falling on the administration, meaning governments, hence the need to analyse ICT and education policy.

The Kenya government proposed the use of ICT to supplement current resources in a bid to remedy the digital divide as well as integrate ICT in schools with mixed results [10]. The introduction of the tuition-exempt primary education in 2003 was to fulfil the Education For All (EFA) promise as well as to improve overall education outcomes which included ICT Integration. The result has been enrolment increase in many countries, Kenya included, but, the quality of education is falling due to the surge that has overwhelmed the infrastructure. The result is overcapacity in classrooms, overworked and frustrated teachers and overstretched resources on a limited education budget [10], [14],[15]. The role of integrating ICT tools in teaching and learning activities in Kenya is carried out through Kenya Education Sector Support Program (KESSP). The National ICT Strategy for Education and

Training [16] bears the mandate to achieve Education for All (EFA). Despite these efforts, ICT integration and e-learning is mostly not established especially for the neediest groups.

In ICT policy adoption and reforms, most literature considers the administration as the key decision maker [10]. But, as with many African countries, policymaking is influenced by external factors such as donor agencies, aid dependency as well as a lack of policy debates among the involved stakeholders. These hinder a coherent ICT development action plan that serves all equally [10]. This situation, argue scholars, prioritises the ineffective top down approaches as opposed to noble cases of technology led community-based organisations [17] and the exploration and use of low-cost computer technologies [18]. Despite the efforts to extend access to education and to integrate e-learning as an aid in education, quality education as well as e-learning is only accessible to the privileged which leads to further inequality [19], [14]. In primary schools the government is expected to bear the cost but instead encourages private sector facilitation which though more reliable is more expensive. Due to this, where ICT integration is achieved, there are frequent extra financial burdens incurred [7]. Other policy stakeholders have also contributed to the debate on ICT integration. For example, on digital dividends, the World Bank reported that a lack of strong absorption capabilities in the digital technology sector would lead to meagre benefits [20]. With education cited as undoubtedly the major foundation of sustainable growth, without ICT integration, digital dividends would not be realised for the next generation. According to UNESCOs 2015 [21] report, mostly efforts fall short as resources such as infrastructure and human resources are unable to meet expectations of the reform strategies proposed. It reports that ICT can play a role in enabling universal access to education, boost equity and enrich delivery of quality learning and teaching. To establish this, mindset changes from the stakeholders including educators, curriculum developers, administrators and policy makers, is necessary. Thus, there seems to be an agenda on paper but in practice, digital learning policy framework is not effective especially for the poor who need it the most [22], [17].

On the practical side, poor allocation of resources is cited as the key hindrance to the integration of technology in education [7]. This is despite the backdrop of the widely recognised position that ICT integration relies on more than access and resources, that ICT is key to gaining global competences as well as enables the taking part in the current connectedness as pathways to resolving current global challenges [22], [23]. In line with SI principles and in a bid to leverage the ICT promise, Kenya has formed partnerships with actors in the private sector, a case in point being between Microsoft and the government [22], [4]. Two issues arise from this, firstly, this is a demonstration by the government of its incapacity to deliver education, the second is to what extent can large scale private companies be relied on as providers of infrastructure and equipment for long-term public projects [4]. Despite these issues in policy and practice, ICT is still considered key to enabling development, the next section examines why this is the case.

3.0Prioritising ICT in developing countries

The reasons given as to why IT is important can be viewed from a micro to macro level. On the micro level, the weight accorded to the role ICT can play and therefore the need for integration firstly falls on its capacity to support the enhancement of intellectual and rational abilities. It has also contributed to positive learning outcomes [24]. On the macro level, in his 2008 paper, Richard Heeks[4] argues that firstly, it is a moral argument for ICT experts to focus less on corporates and offer some attention to resolve some of the planet's mega problems such as climate change, conflict, terror, diseases and resource depletion among others issues. These he claims are stacked up against and faced by the poorest people who live on less than 2$ a day. The second reason he cites is self-interest as transference of these problems in the forms of migration, terrorism and diseases can and is happening in a globalised world. Thirdly he also argues that designing a system that resolves an issue in a developing county and that then contributes to poverty reduction offers a greater sense of satisfaction than just more of the normal setups required by corporates. It would also lead to the empowerment of the poor which he proposes would offer a market base. Overall, the economic social and political life in the 21st century will be increasingly digital and those without digital skills will be increasingly excluded [16], [25], 26].

Discourses regarding ICTs importance begun over thirty years ago. In development studies Information and Communication Technologies for International Development (ICT4D) 1.0 and its progression to ICT4D 2.0 were the buzzwords which represented the IT path to integration [4]. This path has moved through the development phase, MDGs, bottom of the pyramid, proliferation of ICT especially mobile phones from 2000 onwards and SDGs right to the present. Mobile phones are having an impact on lives in poorer communities and has led to interdisciplinary involvement in ICT research. Computer scientists are developing apps, sociologists and anthropologists are encountering mobiles in their studies and in development studies, where in the last decade ICT was scarcely mentioned, Robert Chambers [27], now talks of a cornucopia of potential referring to a new domain of participatory action. Despite all this effort, the results are mixed - mostly failure, restriction and anecdote. These outcomes have led to specific lessons and new watchwords including (a) sustainability, where ICTs failure to deliver and survive begged the need for longevity, (b) scalability, where expansion or replication of individual telecenters was hindered and (c) evaluation, which was to ensure the hype was corroborated through objective impact evaluations [4]. Gender had been largely ignored despite the evidence that ICT could play a role in empowering women in several ways [28]. There is interesting work regarding this by Oreglia& Srinivasan [29] on how or whether they can renegotiate their patriarchal social structures. One of the main challenges to ICT Integration is learning. The next section attempts to analyse learning in ICT Integration.

4.0Learning and Change

The goal for ICT integration is to enable development, the challenge is enabling learning that leads to development. From 2000 onwards, a recurring challenge has been to accurately define development with relation to ICT [2]. Efforts include published work on the Human Development Approach with its links to the ICT as artefact [30], the demonstrating of theories of development as applicable to specific e-commerce approaches [31] as well as Gallivan & Tao [5] who draw on Sen [32] and the capability approach (CA). There is no prescribed or specific method to integrate ICT although attempts have been made by scholars to develop theories and methods [10]. Learning aids include the use of text recommendation systems such as Balabanović's work which delivers appropriate content based on a learner's experience and feedback preferences [33]. Polydoropoulou&Lambrousuggested a content advisory system that was helpful in the studied shipping industry as it enabled the effective adaptation to new roles and responsibilities [34]while others have developed the aptitude-based system [35]. Wang suggests that in order that independent learning is enabled, e-learning systems need to be guided by personalised learning adaptation and a self-regulated learning environment which would enable efficiency [36].

Several studies have been carried out to establish theoretical bases for technology adoption [7]. Examples of these include models such as the theory of reasoned action (TRA) developed by Ajzen& Fishbein [37], the theory of planned behaviour (TPB) [38], and the theory of acceptance and the use of technology (TAUT) [39]. These models have been applied by scholars to empirically illustrate the appropriate models which support student's acceptance of learning environments [40].Heeks[4], proposed two approaches on how diffusion would occur as either 'passive diffusion' or 'active diffusion'. Passive diffusion allows the progressive spread (as is happening with telephones) to result in profit for private firms and value for the poor. On the other hand, 'active diffusion' believes the market will be slow to support the poor hence the need for innovations that better meet development goals. Lessons learnt in ICT4D 2.0 were that large-scale operation proved risky and not successful therefore the emphasis was on smaller scale efforts executed by either adapting or applying existing technologies that may be in forms of pro poor (outside the community but on their behalf), para-poor (working alongside the poor), and per-poor (within and by the poor) [4].

Adopting ideas from grassroot innovations for sustainability is increasingly getting attention in policy, academic and activist debates but little research has specifically been conducted on how transformative perspectives, strategies and action emerge [41]. Results arising from these strategies found that micropolitical and macropolitical factors are drivers that influence the emergence of first- and second-order learning. In turn, this learning moulds three different strategies proposed by this grassroots initiative, namely: commercial, social, and empowering strategies. Challenges to ICT integration and e-learning are persistent and ongoing as they

echo general developmental challenges. The next section is an overview of these challenges.

5.0 Digital learning challenges: barriers to learning

Without the integration of ICT in education, education reform is incomplete [42]. The use of traditional approaches to teaching and the learning environment seem to hinder the development of information access and in turn widening the knowledge gap. This is then broadening the digital divide and can only be mitigated through effective ICT integration [7]. Awareness, access, attitudes and applications is the 4A perspective which focuses on digital gaps at the local/community level and also applies to the national/global levels [12]. The challenges with ICT integration can be analysed from the macro basis and micro basis although looking at the macro approaches are marred with records of failure [7]. Complex policy environments as a result of multiple stakeholders, technocentricity and a lack of contextual considerations are key barriers.

In policy terms, a multiplicity of actors each with their own agenda are involved in delivery of services that may be best designed and delivered as public [7]. These may operate outside of a policy framework and within environment with unclear agendas which may not be of national interest moreover they mostly lack coherent policies. Technocentricity and contexts emerge as barriers. Technocentricity is described as situations where computer scientists create technically sound systems but which fail to make any developmental contributions [4], [7]. Critics of technocentricity claim that attempts at integration are made without considerations based on preference which relates to the issue of context. Context and cultural aspects pause difficult barriers to implementation of ICT as they represent the social basis within which technology is interpreted and given meaning [43]. ICTs therefore should be conceptualised from social systems within which technology is considered another dimension [23]. Developing countries lack access to relatable, culturally conscious digital content [44], [39]. To establish context and content, key themes arise which include participation and collaboration Korpela[45], indigenous design [28] and efforts be embedded ICTs within wider change efforts [3], [23]. On the same thread lies the debates on standardisation verses localisation [2]. Generally, policy and context are older themes which still have echoes today although others have also come to prominence, an example being the interdisciplinary aspects that are lacking and are required to enable effective, transformative integration [46]. Within context also lies lack of gendered consideration [12] that is ignored by some ICT scholars claim Walsham and Sahay [2] but is deemed key by others includingBrännström [46] and Gillard [47].

On the micro level, access is the biggest challenge among the neediest. Warschauer [26] states affordability as a major factor that widens the digital divide creating a gap in the knowledge society. Studies thus demonstrate that the digital divide is

bound to widen if the underlying issue of affordability is not addressed [26]. There is very poor infrastructure in terms of roads and access meaning long journeys and even should access be guaranteed, power outages and expensive alternatives for power generation then hinder access. Together with these, internet connection is very poor in remote areas. Access is further hindered by inadequate human resources where skill and empowerment disparity in terms of access and end-to-and proficiency in technology is commonplace. Studies such as one done by Ali &Magalhaes [44], and Butler &Sellbom[48], found language barriers, workload and lack of time as further barriers. Al-alak&Alnawas [49] identified perceived usefulness, ease of use, and prior computer knowledge as key barriers.

The idea of the PC and internet connectivity are the barriers in themselves claims Heeks[4] as the cost of units as well as the internet for the poorest makes this an impossible idea. Heeks mentions (a) terminals, meaning low cost computers in initiatives such as one laptop per child (OLPC) as one prominent product, (b) Telecommunications especially wireless options are popular, and finally, (c) power with only 15 % of rural household having electricity means the need for new low-cost devices for electricity generation and better ways to store carry, transmit and reduce power consumption. He poses the challenge to focus less on the PC and move towards mobile phones. There are lessons to be learnt from attempts at ICT integration which form the springboard that would enable better ICT integration in future. A Full evaluation of ICTD interventions is difficult as its outcomes are often intangible in nature [50]. A way around this is not to focus only on impact but on other elements in the project life cycle.

6.0 Possible Solutions

In terms of what development means, ICT integration ideas need to move from the simplistic notions of access and finance as barriers. Scholars such as Gigler, [52] drawing on Sens Capability Framework to examine the impact of ICTs on disadvantaged communities. He goes further to identify a more complex ICT impact chain. This implies a need for enhanced capabilities including, information capabilities for the poor, communication capabilities, information literacy and knowledge sharing abilities. Gigler [52] emphasises the role of intermediary organizations in supporting disadvantaged communities to harness and develop necessary skills. Solutions also lie in the development of ICT models which transform processes and structures of development such as connecting the excluded [4]. SI as social enterprise models based on ICT and other unique practical ideas such as political and conflict analysis models of which Ushahidi are examples to learn from [46]. Context as emphasised by Mandon[53] plays a role, she argues that technology-based projects must not be studied in isolation but within the broader historical processes of development and governance as evolved within the said context. In the same grain Slater [54] in his book talks of western centric notion of development meaning to raise developing country standards to western ones. He argues that terms such as new media, globalisation and development should be sought and grounded in diverse everyday street life.

There is an agreement that gender as an issue is important for ICT integration. On women and ICT [46] insists that it is a topic that must not exclude men given that both male and female attitudes are important and that the study of ICTs becomes part of the mainstream. Women play a critical role where ICTs are introduced such as entrepreneurship, health, education, agriculture, and, commerce which then means that in future gender should feature in ICT in a major way [47]. Specific gendered challenges need to be addressed to enable access [53].

Considering access and finance, several solutions are proposed. Heeks[4] observing the challenges of the PC route, proposes the use of mobile telephony and tablets as having better potential. Mobile phones already reach more than half the African population. He however insists the calls and SMS only models need to be replaced by smartphones to offer better platform for exchange and learning. Innovation requirements are thus that the bottom-up smartphone diffusion rises to meet the top-down lower cost PC terminals and not to forget the over 80% who already possess radio and television sets [4]. Tabira and Otieno [10] also cite the use of pre-recorded DVD based content as an effective solution and that teachers are best suited to lead in the design of the material in a community of practice of teachers. Pedagogically designed content is argued as one of the pathways to enable learning [7]. This should occur in and iterative collaborative fashion as opposed to the traditional top-down approaches [10]. Wang's study shows how such content in the form of interactive flash animation improved elementary learning [36]. This can be amplified on a large-scale deployment plan when reliable and authentic content is developed even without the help of instructors [55]. This is however dependent on quality of content and ease of use. The internet thus provides a platform for a variety of content in the forms of non-commercial, commercial, or open courseware which can be used as supplementary to the main content [7]. Open source systems, single board computers or microcomputers are cheaper than regular computers thus limiting the issue finance as barrier.

The deployment of e-learning on a larger scale may still mean maintenance fees and updating costs which could be expensive in the long run. A Community based service preference addresses needs such as allocating for communal diversity necessary for participation, ownership by community thus ensures public acceptance, increases and fosters entrepreneurship and innovations such as e-commerce, virtual banking and e-villages. These however have limitation such as lack of scope and grappling with trying to unite segregated initiatives [7]. Thus, the onus is left for governments to develop policies which promote innovation on digital content as well as initiatives to improve internet connectivity for impact.

Among scholars' criticisms of efforts at ICT integration are that there should be a move beyond mere application to more attempts at theorising development issues [4], as well as move the focus on the market regime as if the only possibility for ICT application lies in economic and social gains [3]. In later research and

observation from conferences, the GRACE Network is lauded for its transdisciplinary core [46]. He criticises the newer ICTD conferences as either ignoring development theory, and while multidisciplinary in attendance, scholars attend session within their discipline and therefore negating the interdisciplinary potential. A final criticism is the lack of delving into the political and economic agenda such as which technology is being pushed for and why.

7.0 Conclusion

Digital technology is prevalent, but questions remain as to what extent it is contributing to development and how it can be harnessed to produced results. Studies have shown that e-learning can play a role in schools. Efforts at integration in low income countries result in growing inequalities as mostly the privileged can gain access to ICT, contrary to efforts the aim which is to include the less well off. Government policies are often set up with the aim of working in conjunction with stakeholders whose agendas may not be aligned to what it takes to actually enable working integrated ICT and e-learning systems. ICT integration's significance includes the development of cognitive levels and what this means for development and inclusive citizen participation. Globally ICT integration plays a moral and self-interest role. Heeks[4] argues that to ignore developing countries is to the detriment of the West as with globalisation and migration, a more equal society serves to enable positive exchanges socially, economically, culturally and politically.

Enabling learning is key to integration. This applies to both learning from past ideas, successes and failures as well as e-learning which is actual application or use of and application of digital platforms. Debates suggest that together with access, context is important and even more important ensuring that theory and practice are applied to integration efforts. The Human Development and Capability Approach (CA) offer theoretical basis though which integration can be analysed to enable results. Gender must also be considered not just as creating opportunities for women but including both sexes when developing ICT policies. This is to ensure gender does not mean a limitation to access.

In ICT, discourses have generally remained the same namely sustainability, scalability, and evaluation. What comes across is therefore the need to find a path to progress. Scholars are still in favour of the administration as key when it comes to ICT integration which would ensure inclusivity. Governments are also taxed with the role of enabling structural access especially to the neediest. An emerging discourse is the role that a transdisciplinary approach could play. Given the persistence of unresolved underlying discourses regarding ICT and e-learning, the complexity of factors that affect learning and therefore integration will be best resolved when transdisciplinary teams work together.

Recommendations for further research are mainly derived from scholars' criticisms of efforts at ICT integration. The first is that there should be a move beyond mere application to more attempts at theorising development issues. The second is toshift the focus on the market regime as the only possibility for ICT application to incorporate aspects beyond economic and social gains.Thirdly,pursue, experiment and highlight efforts at more interdisciplinary approaches and lastly delve into the political and economic agenda such as which technology is being pushed for and why.

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Digital Game-based Learning in Education: Significance of Motivating, Engaging and Interactive Learning Environments

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Abstract

It is beyond doubt that the digital era has drastically influenced the everyday life and pursuits of modern students. Due to the technological advances and digitalisation of life, students' needs and requirements regarding education have changed. Hence, they are seeking for more fun, interesting, motivating, engaging and interactive learning environments and experiences and they are no longer satisfied with and attracted by traditional educational methods. Nowadays, due to their popularity, digital games are increasingly applied in education. Digital educational games or serious games focus more on primary purposes and offer motivating and engaging experiences, interactive learning environments, collaborative learning activities and continuous feedback. These games can satisfy and fulfil students' needs and requirements and improve learning processes, thus, they are regarded as appropriate and efficient educational tools. The pedagogical approach of utilising digital educational games is named digital game-based learning and can be described as the connective bond between interactive entertainment and serious learning. Game-based learning promotes collaborative and stimulating activities, as well as student-centred learning environments, in which students' mental and psychological wellbeing and soft skills are cultivated in a dynamic, entertaining and creative manner. This study describes the emergence of new educational needs and requirements, analyses the

concept of digital educational games and the digital game-based learning approach and presents their main attributes and benefits. Furthermore, it describes and summarises the main qualities and potentials of this approach as an educational tool and as a means for creating motivating and engaging experiences, as well as interactive learning environments. Finally, it points out the significance and the need for developing such environments and experiences in education and it analyses their individual elements.

Keywords: Education, Game-based learning, Digital educational games, Interactive learning environments, Motivation and engagement.

1.0 Introduction

An appropriate, noticeable and respectable way to improve learning process is play which is considered to be a common activity and a significant mediator for people's learning and socialisation throughout their life [1]. It constitutes an intense learning experience in which the participants willingly and eagerly invest time, energy and commitment while at the same time they derive great enjoyment from the overall experience [2]. Through play, people can mature emotionally, develop social and cognitive skills and make sense of the world around them.

Nowadays, due to the rapid technological advances, play in the form of digital games is gaining ground. Digital games are considered as the most popular computer related activity in the home [3] and have become an integral part of our social and cultural environment [4]. It goes without saying that entertainment is the main reason why people spend many hours playing games, but in fact what primarily keeps them engaged are the approaches and principles embedded in the game designs which facilitate and enhance positive learning outcomes [5, 6]. Advances in Information and Communication Technologies (ICT) and life digitalisation in the twenty-first (21st) century offer new ways and methods to promptly access and retrieve rapidly flowing and changing information from various sources. Moreover, students living in the digital era are being informed and learn through different means and manners compared to previous generations [7]. Hence, new educational needs and requirements are developed and students seek for more engaging and interactive learning environments as they are no longer attracted by and keen on traditional educational methods and systems [8]. Furthermore, the relevant to the 21st century skills which are vital to the digital global job market differ dramatically from the skills valued by the current educational system.

Digital games, when applied in education in a student-centred manner, can create engaging experiences, interactive learning environments, as well as collaborative learning activities [8] and can provide new teaching and learning means. Moreover, digital games also render the development of the 21st century skills necessary as they are highly valued in the new digital economy [9]. Thus, they can be considered as a powerful educational tool which satisfies and fulfils students' needs and requirements and enhances learning process.

This study describes the emergence of new educational needs and requirements, analyses the concept of digital educational games and the digital game-based learning approach and presents their main attributes and benefits. Furthermore, it describes and summarises the main qualities and potentials of this approach as an educational tool and as a means for creating motivating and engaging experiences, as well as interactive and student-centred learning environments. Finally, it emphasises the significance and the need for developing such environments and experiences in education and it analyses their individual elements.

2.0 Modern students' new educational needs and requirements

Nowadays, students grow up with ICT, handle digital information on a daily basis and have been significantly influenced by the digital era which provides novel and unconventional learning methods [7]. Modern students have prompt access to a wide variety of rapidly flowing digital information from various sources and thus, learning occurs in the background during their daily life. They are more accustomed to digital media and multi-tasking and play games to a greater extent compared to those in the past. More specifically, as students mature and form their personalities in the light of flexible communities, they request prompt responses, seek to be directly connected, require social interaction and opt for learning based on experiences [10, 11]. Furthermore, they require continuous and prompt interactions with digital content, prefer inductive reasoning and have excellent visual literacy skills [12]. Hence, it is without doubt that their way of thinking, their perception of effective learning, as well as their educational needs and requirements have drastically changed.

According to Schaaf [7], traditional education delays adopting and embracing new and experimental methods and approaches. Consequently, it often lags behind in innovation and redirection [7] as it still uses conventional and obsolete paradigms, means and tools which are not effective in educating the new generation of digital natives [13]. It is obvious and understandable that modern students become disengaged and uninterested in conventional educational systems and approaches. As a result, students seek for more engaging learning experiences and interactive learning environments which develop and polish the essential for the 21st century learning and innovative skill sets. In addition, either centralised or distributed team oriented interaction and communication skills are usually required in order to accomplish professional duties and responsibilities in the 21st century global job

market [14]. Some of the most important skills that have to be taught to students and further developed are: cognitive and soft skills, communication and collaboration, critical thinking, decision-making and problem-solving skills and creativity [7, 8, 9].

3.0 Digital educational games

In contrast to the conventional educational approaches, games, when properly applied in education in a student-centred manner, can yield a lot of innovative and positive changes. They can also promote, develop and enhance engaging and interactive learning environments which comprise a key feature to today's students. Moreover, games have a long-standing tradition in education as they have always been an essential part of the human learning experience in both formal and informal settings [15] and embody well-established principles and models of learning within a specific context [12]. Additionally, games satisfy the basic requirements of a learning environment and provide engaging learning experiences for students. Due to the technological advances and the increasing research into the impact of digital games on education, we can now rip the benefits offered by digital games to improve the educational learning process and support the development of the essential for the 21st century skill sets [9]. Furthermore, digital games expose students to values, rules, instructions, standards and multiple perspectives which students should possess in order to function in the new global market [7]. Moreover, as students seem to concentrate more while absorbed in computer-based learning, educators pursue to attract students' attention and interest through digital games so as to achieve specific learning goals and outcomes. Hence and with a view to supporting and enhancing learning processes, an increasing number of educators are experimenting with alternative ways to incorporate and utilise digital games for educational purposes.

Kinzie and Joseph [16] defined games as "*an immersive, voluntary and enjoyable activity in which a challenging goal is pursued according to agreed-upon rules*". Moreover, Van Eck [12] stated that games thrive as educational tools when "*they create a continuous cycle of cognitive disequilibrium and accommodation while also allowing the player to be successful*". Digital educational games can be defined as computer-assisted instructional tools and techniques in which skills and chance are combined and implemented on previously acquired information and experiences developing, thus, engaging and immersive learning experiences in order to achieve specific learning goals, outcomes and experiences [8, 11, 17]. Digital educational games have a versatile nature which allows for easy adaptability and is capable of creating situated learning environments in which students acquire, establish and share knowledge and skills while playing [7, 18]. Digital games are mostly implemented in education in the form of serious games. Particularly, "serious games" is a term which describes any student-centred game-based initiative which focuses more on primary purposes than just pure entertainment and it mostly refers to the use of digital games in education and various industries [8].

With the aim of rendering learning more student-centred, engaging, fascinating, interesting and hence, more efficient and effective, well designed educational games provide complex holistic problem-based environments, involve educational goals, support active and situated learning, promote collaboration and communication [3, 5, 9, 13, 19]. Educational games are often social in their nature, are based on defined rules and have several levels of varying degrees of difficulty through which students gain new skills and learn new strategies in order to overcome obstacles, meet challenges, clear tasks and accomplish objectives, all while learning in a safe environment [17, 20]. They allow students to develop their logic and soft skills, as well as acquire and share knowledge while being engaged in an entertaining and interactive environment [19]. As games provide multiple paths into success, students are given the opportunity to take decisions and make choices reserving the right to be wrong without adverse consequences [20]. In addition, due to their uncertain outcomes, the multiple game goals and the different levels of difficulty, games provide incentives and challenges to students and keep them engaged and motivated [11].

3.1 Attributes and benefits of educational games

Educational games have many attributes that facilitate and promote the development of stimulating learning environments. Their main drive is the gaming activity itself and they start with a premise to be solved or completed [20]. With a view to enhancing instructional effect, ensuring cognitive success, as well as reinforcing students' interest and enriching their learning experience, educational games typically implement multimodal content representation in combination with entertaining, interesting and engrossing elements [15, 21, 22]. Furthermore, utilising educational games as a teaching and learning tool can i) promote students' participation, learning motivation, enjoyment and eagerness, ii) enhance their academic accomplishments and social attainments and iii) improve their higher order thinking skills and improve critical and cooperative behaviour [23, 24]. It is beyond any doubt that educational games affect students' creativity, problem solving skills, critical thinking, spatial ability, collaboration, conceptual understanding, automaticity and a host of other higher order thinking skills actively and positively [25, 26]. Hence, they promote and enhance students' tranquil state of mind and maintenance of social contact and interaction.

Dabbagh et al. [26] defined keen motivation and engagement, experiential, feedback driven and contextual learning, as well as interactive learning environments and student-centred learning approaches as the key attributes of educational games. Moreover, based on [13, 19, 21, 22], there are some additional game aspects which influence students' motivation, engagement and enjoyment such as curiosity, fantasy, role-playing tasks, rules, goals, challenges, competition, control, fun, motivation, interaction, adaptability, feedback and multimodal presentation.

4.0 Digital game-based learning in education

Game-based learning is the pedagogical approach which utilises games in the broad sense in education and allows students to be involved in educational material and subjects in a dynamic, enjoyable and playful way. Moreover, it can be described as the act of designing and developing interactive learning game activities that can gradually convey concepts and direct students towards an end goal [27] while simultaneously providing them with a rewarding feeling of achievement and progression [8]. Game-based learning can be considered as a teaching method in which game content and gameplay allow students to explore various game parts as a means of learning to help them acquire new knowledge and enhance their set of skills while achieving specific learning goals and outcomes [8, 9]. For all those reasons, Prensky's [13] assertion that educational software design should be formed and based on game design methods and techniques is increasingly gaining popularity and acceptance [3].

With the aim of promoting motivation, a new game-based learning approach named digital game-based learning, in which digital games were incorporated in combination with curricular contents, was presented by Prensky [13]. Additionally, he defined the key characteristic of digital game-based learning as the "*coming together*" of interactive entertainment and serious learning through digital games [13]. Perrotta et al. [28] defined intrinsic motivation, learning through intense enjoyment and fun, authenticity, self-reliance and autonomy, as well as experiential learning as the key principles involved in digital game-based learning. Furthermore, they determined set rules and goals, fictional settings, progressive difficulty levels, high control and interaction, prompt and constructive feedback and social involvement as the key mechanisms of this approach.

Digital game-based learning is a student-centred learning approach that utilises digital games so as to support educational purposes [28] and provide students with the ability to learn, comprehend, retain and share new knowledge and information while utilising their preferred learning style [7]. Moreover, this approach combines digital games and educational content and material to stimulate students' interest and provide them with the potential to enhance their learning efficacy. As a consequence, students view knowledge and education positively and continuously pursuit learning throughout their life. Games designed in line with this approach allow students to practise their skills in a virtual, simulated and safe environment and promote collaboration and communication, as well as the development of cognitive and soft skills.

5.0 Significance of motivating, engaging and interactive learning environments

As it has already been stated, modern students have new educational needs and requirements, have lost interest in traditional educational approaches and are seeking for new learning environments and approaches.

Educational games and digital game-based learning in particular can provide students with interesting, intelligent, adaptive, motivating, engaging and interactive learning environments [18, 29, 30] and help them cultivate their minds and spirits, enhancing thus their overall learning efficiency [22]. Furthermore, digital game-based learning environments include preset rules and goals, prompt feedback and gradually changing difficulty level [31]. They also have the ability to promote students' self-efficacy through challenging experiences in a social and collaborative environment [8] and dynamically adapt to students' current state of knowledge. Educational games promote innovative thinking and constitute an excellent tool that can facilitate situated learning and support students' learning experiences [10, 13]. They help create a more interesting and interactive learning environment in which students could acquire and share thoughts, knowledge and experiences [3, 30]. Additionally, they promote excitement, stimulation, engagement and the feeling of accomplishment and as such, they are widely considered as a great means to facilitate learning and combine meaningful learning with fun [4, 5, 6, 10, 13, 25]. Hence, they can be regarded as a constructivist and student-centred learning environment in which the vital and interdependent components for productive learning are woven together [32].

The effectiveness of cognitive learning experiences depends not only on the learning process and methods used but also on students' active and continuous motivation, engagement and interaction. These significant learning elements are analysed below:

5.1 Motivation

A key factor in captivating students' interest and enhancing their learning ability and performance is motivation. According to Bomia et al. [33], motivation, in relation to education, refers to *"a student's willingness, need, desire and compulsion to participate in, and be successful in, the learning process; it seeks to increase the factors that move a student toward becoming more involved in the class and the subject matter"*. By offering students motivation which responds to a specific set of physiological processes, their direction, vigour and persistence are positively influenced [31]. Moreover, educational games can promote effective learning and motivate students by offering them opportunities to actively and critically experience, practise and express their ideas in a problem-based situated and low-risk content [4, 5, 6]. Additionally, they have an intrinsic motivational factor that fosters curiosity, encourages students to become involved in games in a personal, emotional and cognitive way and makes them believe that they are in control of their own learning [15, 29]. According to Prensky [34], by adding the element of motivation into the learning process, learning does not only become more enjoyable, compelling and engaging, but also more effective and efficient. According to [11, 35], challenge, game realism, opportunities to explore or discover new information and control are the main reasons why students become highly motivated. Furthermore, Yee [36] defined the following three main components along with their subcomponents that enhance students' motivational aspect when utilising games in education: i) Achievement (advancement,

mechanics and competition), ii) Social (socialising, relationship and teamwork) and iii) Immersion (discovery, role-playing, customisation and escapism).

5.2 Engagement

According to Gee [5], educational games offer *"deeper insights into human thinking and learning, as well as engage learners in deep and engaged learning*". The term "student engagement" refers to students' conscious and meaningful involvement throughout the learning process. Student engagement affects and is affected by enjoyment, learning and motivation and consists of behavioural, emotional and cognitive engagement. Generally, students get engaged when they are actively involved and persist in accomplishing their goals in spite of challenges and obstacles. Educational games encourage students to learn, stimulate their ability to think and include multisensory settings contributing, thus, to the creation of safe, positive and creative learning environments [37]. According to the model presented by Abdul Jabbar and Felicia [37], engagement affects all stages of learning. In this specific model, cognition, thoughts and emotions as well as continuous i) knowledge and skill acquisition, application and anticipation, ii) skill practising and content processing and iii) reflection (feedback) play a central role in students' engagement and learning process.

5.3 Interaction

Interactive learning environments have drastically evolved due to the rapid growth of digital technology, social media, urban computing and virtual communication. Hence, modern students expect them to be an integral part of their education and learning process. As educational games help develop and promote interactive learning environments, they are used in a range of different learning contexts to promote and support progressive learning through experience, engage new learners, support learning construction and aid in the development of skill-based learning [23]. Digital games immerse students in virtual worlds by means of role-playing and community interaction and allow for immersion and intense, interactive and extended experiences with problems and contexts similar to that of the real world [38]. The digital game-based learning approach supports the theory of situated cognition [39], as it is based on the fact that knowing is inseparable from doing and efficacy of learning is achieved through experience within a social, cultural, physical and digital context. Doing involves direct and simulated experiences and promotes students' interaction [35]. Moreover, digital game-based learning helps students play to learn and learn to play [7]. Hence, learning efficiency is closely related to students' active participation [40].

6.0 Conclusion and Future Work

Nowadays, education still has not fully adapted to the technological advances and the digitalisation of everyday life and focuses on factual and fundamental knowledge while it should also lay emphasis on preparing students for their life ahead. As a result, new educational needs and requirements have arisen so students look for modern and interesting learning methods and approaches and seek for

more stimulating learning environments and engaging experiences. Hence, education should not simply stick to traditional forms but should be reformed and utilise contemporary techniques, methods and technologies to reinforce teaching and learning processes. The digital game-based learning approach can be utilised as an educational tool which can boost students' wellbeing, self-esteem and autonomy, help them improve their soft skills, develop their critical thinking, decision-making and problem-solving skills, as well as maintain a healthy mental and psychological balance. With that view, the emergence of new educational needs and requirements was presented, the concept of digital educational games was analysed and their attributes and benefits were described. Moreover, the digital game-based learning approach was presented and analysed and the main qualities and potentials of this approach as an educational tool and as a means for creating motivating, engaging and interactive learning environments were summarised. Finally, the significance of developing such environments and experiences in education was pointed out and their individual elements were analysed.

In conclusion, when applied in education properly and in a feedback driven and student-centred way, the digital game-based learning approach and educational games can be effective educational tools that can facilitate students' learning process, enhance their cognitive and social-emotional growth, as well as promote and improve their interaction, collaboration and communication. Moreover, they can instil interest in educational issues and create motivating and engaging experiences, as well as student-centred and interactive learning environments in which students would participate eagerly and actively.

Future work will concentrate on pedagogical experiments using digital educational games and digital game-based learning approaches in Higher Education (HE). Several educational games have already been designed and developed. The next step will be to design and conduct experiments in order to measure and assess the impact of game-based learning on students' learning performance, engagement and motivation.

7.0 References

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Making Sense of Digital Content Strategy, Higher Education and Student Recruitment

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Abstract

Big data has led to an extremely large amount of information appearing online which requires additional capturing, organising, analysing and storing. The change also demands information systematisation, new approaches to the online content management and development of the relevant software. The issue is highly relevant to higher education institutions (HEIs) than ever before, given the complex market situation – severe financial and strategic competition, i.e. continuously added/changing government policies, rising tuition fees and decreased student numbers (due to low suitable-for-HE-age population and general concerns about the potential debt). Current prospective students are better technologically equipped and educated. As the online users, they require swifter access to the relevant website content, via multiple devices, with the opportunity for two-way communication and quick response times to enquiries. If the intention is to stay in the market for the long-term, institutions need to adapt to the new market requirements and technological needs of the modern key stakeholders. Thus, successful student recruitment is vital, yet, at the same time, hard to achieve. This paper proposes a solution in the form of a digital content strategy (DCS). The strategy enables effective planning of quality content and online data management which can, potentially, provide distinction in student recruitment and a unique position in the HE market.

Keywords – Digital content strategy, content marketing, content analysis, big data, Higher Education

1.0 Introduction

The benefits of higher education (HE) to individuals and to society at large are often underestimated. The majority of economists, however, agree that "a nation's human capital and the new ideas and innovations generated by that human capital constitute a major engine of economic growth" and making the necessary investment to the "nation's long-term economic success" [1, pp.1-2]; and "the provision of higher education makes a valuable contribution to the UK's economic and social development" [2, p.494]. Severe competition and a complicated market situation, nonetheless, require from institutions adaptation to the new digital marketing position, as the websites are currently the first point of information for prospective students. Furthermore, "Big Data" has facilitated extremely large amounts of information appearing online. This data requires analysing, capturing, storing and organisation, due to "volume, velocity, variety, variability" and "complexity" according to the Statistical Analysis System Institute [3]. Technologically savvy users require modern software and technology; powerful social media presence; original, educating and entertaining content; hence, overall – a new way of digital thinking for organisations. This directly relates to the HEIs' quality online presence, particularly in terms of the brand image, reputation and student recruitment objectives; and despite the significant research efforts, institutions are struggling to keep up with the pace. Modern researchers introduced a novel concept as a potential solution – content strategy – which has become more and more valuable, particularly digital content strategy. There are, nevertheless, diverse meanings, an ambiguity and disagreement in how content strategy is defined. It is critical, however, to have one definition for potential implementation by higher education institutions towards the achievement of the desired student recruitment.

2.0 Methodology

The Research was focused on the data collected from both – academic sources and trade publications, as an integrative approach generates "new knowledge about the topic reviewed" [4]. The sources were reviewed in relation to their significance for the research, applying the "Snow-Balling" technique [5]; and the inclusion and exclusion criteria [6] were applied to all the studies retrieved. The received data was then consolidated into a database, and "Thematic Analysis" was applied to identify the patterns in the development of the issues related to higher education and the notion of digital content strategy. The process lasted three years, from June 2015 to June 2018 and mostly included primary studies published over the years. The authors aimed at gaining an understanding of knowledge and practices from the existing research to identify the contextual settings of the aspects, adapting "Thematic Analysis" [7, 8]. The research identified a number of emerging themes argued academically and in the business settings which could be grouped into the following: (i) digital content strategy (content, content analysis and technology and content marketing) and (ii) higher education and student recruitment, further discussed in the literature review.

3.0 Literature Review. Content and Relate

3.1 Content

Content is the soul of a website for any organisation. The notion has been extensively evaluated and researched. Halvorson and Rach suggested one of the most recent and significant definitions suggested – "Content is what the user came to read, learn, see, or experience" [9, p.28]. Initially, a vast majority of researchers merely related content to communication of an idea [10]; later Graber highlighted the issue of the content and meaning [11, p.145]. Nowadays researchers view content as component content management [12, 4], as website "cues" [13, pp.50-51] and as "potential information" [14]. Substantial research has been devoted to the operational side of content, particularly website usability, as the way it is presented online is just as important, as the actual content. Digital content appearance revolutionised the way the content is perceived, particularly in e-commerce, where high quality information content and effective design and functionality became critical for success [15]. Clayton [16] stressed that even where a website appears perfect to website providers, it might not be "appealing to an Internet-savvy generation". Users require "solid interactive content that is specific to [*their*] needs." "If a website is disorganised or text-laden, or offers no way to apply online or take a virtual tour", users may "click away and never return".

3.2 Content Analysis (CA) and Technology

"Content analysis methods may be applied to virtually any form of communication", being an "unobtrusive research method" that is "studying social behaviour without affecting it" [17, pp.295-286]. The development of the notion has gone through a diversity of stages, from basic comparison of religious studies, to newspapers, political, communications and interactive media analysis. A number of authors state that it is expected that quality content management systems provide enjoyable/unforgettable experience, addressing such aspects as: download delay, navigation/organisation, interactivity, responsiveness and content. Key industry specialists insist: on the same content getting transformed across multiple channels [18], adapting user generated content, search engines, designing for mobile, as well as having a flexible, fluid and responsive layout [19-21], with defined roles/responsibilities for content creation and maintenance, processes and procedures [22], considering the content lifecycle and being "software- and platform-agnostic" [18, loc 425]. Professionals also recommend investing in the content calendar [23, pp.46-68] which "keeps everyone on task and on the same page, which ultimately saves time, money, and heartache". Researchers [22-24] and practitioners [19, 20] agree on the overall importance of the actual content over navigation.

3.3 Content Marketing

The empowering of the role of websites in the marketing plans, has allowed for a dialogue, not the atypical marketing scenario [25, p.51], but building relationships with prospective customers via online engagement [25, 26]. Throughout the

research, however, it has become clear that in trading and some academic sources, the definition is often confused with content strategy, possibly due to it being a big part of it. Many studies have investigated the commercial potential of the digital content using a relatively new notion of content marketing achieved via infographics and a story-telling tactic. The notion, nonetheless, is actively popular, accounting USD 67$ Billion in 2014 [27]; with over 1,500 content marketing agencies in as many as eighty countries [28]. Internet users, on the other hand, are "accustomed to free information" [29, p.64], and "customer perceptions of the value of digital and information content are inherently volatile" [30, p.520]. Reports indicate that the United States currently has the largest market for content marketing, while the UK's market is the fastest growing [28, p.28]. Thus, "a multi-facetted approach to understanding customer value is necessary" [30, pp.533-534].

3.4 Content Strategy

"The information should be found and be accessible" [31, p.5], particularly digital [22, 23, 21]; while the importance of having a content strategy could be underestimated. Content strategy is responsible for "the creation, delivery, and governance of content" [22]; it helps to "…understand the gap between your user experience and your customers' needs, introduce and fix it" [18, loc 245; 14].There is still, however, a confusion among the scientists and practitioners on the actual definition, while the implementation is not possible without an articulate definition in place. Some of these variations do not necessary complement each other, while the others are accompanying statements. The contradiction is "Depending on who you are and what you need to do, content strategy can mean a few different things" [22, loc 518]. Content strategy may focus on various aspects of content – technical, structural or editorial [9, p.28]. McGrane [21] stated that a content strategy "is not about technology. It is – how people can work together". It could be argued that the content strategy is summarised as being perceived in the following ways, i.e. as a: (a) content communication or message strategy; (b) unified content strategy; (c) production cycle for digital strategy; (d) systematic approach/process towards developing and government of content; (e) experience and brand image, directly associated with online customer experience; (f) content maturity and omni-channel content strategy; and (g) digital content strategy. In research, the actual term of digital content strategy, in those rare cases of the actual mentioning in various sources, has only been related to the meaning of content marketing, which is only a part of CS. On the other hand, DCS in itself is merely a part of CS, related to electronic material, such as websites, emails, relevant social media platforms and so on. Overall, the notion of CS is currently explained highly distinctively and "The debate over content strategy will continue" [32].

4.0 Literature Review. Higher Education and Student Recruitment

4.1 Changes in the HE market, funding and other issues

The UK HE sector has faced a tremendously hard time, surviving major transformation in the knowledge economy during the last thirty years. The changes intuitively reflected educational transformation in the US [33]. Here are just a few significant aspects. From 1980, Margaret Thatcher's government ended overseas students' subsidies which brought the increase in fees, a significant decline in numbers and a severe revenue shortfall; introduced performance indicators, inviting to follow the USA's HE model, encouraging private resources [34]; and brought a reduction of teaching grants to universities (whilst the fees were increased) [35]. Tuition fees added to this pressure. Introduced in 1998 as £1,000 for full-time undergraduate UK students, they have reached the average of £9,250 for 2019/2020 academic year. Another austerity measure, was the block grant for undergraduate provision, saving roughly GBP £3 Billion pounds; and there seems to be no intention to restore it. Although the intention is to break "a state monopoly", supporting privatisation and commercial companies [36]; at the same time, clearly, "Tuition fees are being introduced or increased, usually at the expense of state grants to institutions. Grants for student support are being replaced or supplemented by loans." [35] Although some researchers stated that the aim is to make individuals recognise the costs of HE and financial commitment [37]; in reality, the marketing and recruitment spending have increased as a result. "The Guardian" argued that raising tuition fees has equally negative consequences for students, as for the UK taxpayers [38] and the tuition fee review saves the government money with no benefits to students [39]. There is expected to be an outstanding balance of GBP £191 Billion pounds by 2046 [40, p.13]. Furthermore, some HEI's income, does not include "wealth or assets or endorsements", being an advantage of the universities of the Russell Group [40, p.7], e.g. one institution generated "six times the mean annual income of £170 Million" in one year [40, pp.115-117); while eleven other institutions indicated financial deficit – in 2015/16 and twenty-four in 2016/17, despite the increase in the fee income from non-EU students and the decrease in the capital income for fifty-seven institutions in 2016/17 [41, pp.4-16]. These HEIs do not receive any additional financial support, apart from recruitment.

The situation in the market has changed drastically. Previously, institutions competed for the best students, whilst students – competed for the best institutions. Nowadays institutions need to get enough students to survive (except elite-level HEIs), while pupils are considering whether to pursue HE studies at all. Other courses (distance learning, apprenticeships, etc.) also create competition. The issue is that there could be a potential "'disconnect' between the hard sell (…message that universities want to give) and the provision of relevant content information" [42, p.719]; as not "all aspects of university behaviour can be analysed from an economic perspective" [43, p.161]. To cope with the competition and to attempt to present institutions in the understandable manner [44], HEIs also indicate their attachment

to the numerous league tables/rankings (NSS, TEF, etc.). These rankings, however, create a controversial debate – from the opportunity to access better teaching standards – to questioning the ways of measurement and further division within the sector. Moreover, according to "The Guardian", there are not enough 18-year olds born to attend HEIs from 2017 for several consequent years [45]; hence, entry requirements could be expected to be lowered and socially-responsible activities ignored to "strip back unprofitable overheads" [40, pp.4-5]. The potential financial crisis related to Brexit could add to market uncertainty. Some opportunities may occur in the longer term, though currently it "poses clear downside" [46, p.19]; while "By freeing the institution from its dependence on a purely local clientele, high academic quality offers the institution greater flexibility" [43, p.12].

4.2 Student Recruitment Process

Student recruitment is currently the key for institutional survival, particularly for the post-92 HEIs. Hence, it has to be addressed at its best. During the last several decades researchers have been offering a few models. Various studies researched how the choice is made, information sources, satisfaction and loyalty [47] and excellence and diversity [48]. Evidently, the institution selection process is complicated, every step of which involves using universities' websites as the key source of information [49]. Hence, each piece of online content should be carefully created and monitored to ensure achieving successful student recruitment. Academics revealed several distinguished ways of HEIs' recruitment strategies, namely: (a) emphasising academic quality (often by well-established universities, "offering knowledge", not persuading to apply); (b) excellence promotion in international recruitment; (c) endorsing HEIs as a "small, different, and exotic" location (with the advantaged student-lecturer ratio); (d) distinctive way of highlighting the diversity, e.g. females in technology, ethnic diversity, disability and/or WP; and (e) advertising research. Researchers stressed that the successful student recruitment strategy is where "practice influences strategy, and not the other way around" [48, pp.364-367]. College-choice behaviour could be related to psychology, sociology and economics, where student characteristics are also the key, especially during an increasing job market or economic recession [42]. This process is complicated, as even now "…little is known about prospective students' information needs when deciding which institution to attend" [50, p.314]. The changes in the requirements from HEIs highlight the significance of online presence, websites development and quality content for student recruitment. Better choices might be based on more information provided; too many choices, however, "can lead to "decision-making paralysis"…", according to HEFCE's own [51, p.9] and other researchers' findings [52]. Although some studies suggest offering more informed choices [53], others found that intricacy of materials available or over-complicated information can discourage potential applicants, thus "…the 'quality' of the information messages provided to the student that is important rather than the quantity" [42, p.718]. The authors evaluated historical patterns in the key factor, influencing student choice and summarised them in *Table 1*.

Table 1. The key factors for college/HE institution selection

THE KEY FACTORS FOR COLLEGE/HE INSTITUTION SELECTION				
HISTORICAL OVERVIEW AND THE PATTERNS IN CHANGING BEHAVIOUR				
1970-1980's	**1980-1990's**	**1990-2000's**	**2000-2010's**	**2010-onwards**
• Nearness/ Location • Cost • Some vague notion of Academic Excellence The text presented to students in university's marketing material to be attractive via used: • Colours • Fonts • Images • Types of texts (bulleted vs paragraphs) • Layouts	• Academic programmes • Quality of units which prospective students intend to undertake • Cost/fees • Location • Scholastic standards • Student life • Socio-economic factors • *Noticed fact (from here onwards):* Students often exclude institutions from their choice set, due to the stereotyping, ignoring the accurate information and entering college with unrealistic expectations	• Parents/ immediate family • Catalogues and other college publications • College/HEIs' representatives • Current students • High school counsellors • Social/cultural levels • Marketing data (only to justify the choice in front of others) • Tuition fees • Entry requirements • Admissions' contact details • Tutors/heads' names • Directions • Timetables • Time to download information • *Noticed fact:* lecturers changed from being "servants" to becoming "entrepreneurs"	The users expected the webpages to be there and to provide: • Quality content (top-10 factor) • Logical flow of online information • Visually intuitive design • The opportunity to apply online and to check the progress • Attractive design – colours, fonts, images, types of texts (bulleted vs paragraphs) layouts and the information on • Jobs/employability aspects • Course content • Student life – overall student experience, the more personal aspects of an institution and the day-to-day experience of attending one, including availability of accommodation, easy transport and safety of campus (logistics, environment and aesthetics) • Sporting/social aspects – social life on campus factors, e.g. events, socialising, being a part of a team, a winning (with self-esteem) team experience and meeting people in general • Money (financial aspects) – tuition fees and availability of financial aid, practical implications of being able to afford an education • Subgroups – in terms of the specific demographics and their specific factor themes, according to information requirements and preferred sources • *Noticed fact:* Having a website is a necessity, as expected by all prospective students	• Course content and quality of teaching • Webpages' suitability for the current hardware and operating systems of other devices, such as mobile phones • Academic achievement and HEIs' prestige • Graduate support and employability after graduation • Accessibility (access by privileged or the vast majority of students) - Educational opportunity for diversity and equality – fair and transparent selection practices, particularly where there is an exceeding number of applications per a place • Affordability – Ability to pay and funding • Accountability – Expectations from HEIs by the society, students and parents • Sustainability – HEI's ability to generate the resources to continuously deliver quality and development, while remaining accessible • Differentiation – Distinction of HEIs on the market among many other competitors • *Noticed fact:* HEIs share a culture of self-interest, avoiding difficult student (to keep good statistics) • *Other noticed fact:* Having a Social Media account(s) is compulsory

4.3 Marketing of Higher Education Institutions (HEIs)

Create an image for your company or your competitors will do it for you.
Keever 1998 [54, p.42]

One could suggest that an HEI's survival is based on "well-built" and maintained brand image, its prestige, respect, status and standing [55, p.276]; however, "The greater the prestige, the more inelastic is the demand for places within the institution…" [43, p.15]. The evaluations of brands may also differ among the public, and individuals often give brands emotional/symbolic values [56]. Hence, the strategy is necessary for building productive relationships [57]. Consumerism had changed the perception of students towards being customers; researchers, therefore, suggest offering a partnership style, promoting education, not the market. Researchers also highlight the disadvantaged position of the post-92 HEIs during this economic recession. The research conducted by Temple *et al*, for example, emphasises that the already-financially-weak-positioned institutions need to become even less research-focused, due to their financial dependency on tuition fees [58, pp.42-43]. Thus, HEIs need to actively develop online presence – websites and social media, using creative approaches, as either are responsible for successful marketing and student recruitment, providing the essential first impression [18, 59] which nowadays takes milliseconds to evaluate [60]. It is currently hard to distinguish institutions among "a homogenized presentation" [61, p.5], though the quality of website data is often associated with the organisation's abilities and trustworthiness. Differentiation on the market is still essential. Some businesses, for instance, advertise their embedded products/services via online games/activities, e.g. "Ninja Thief" online game offers different insurances after the completion of a game [57, pp.11-12]. Universities could also consider offering prospective youngsters an opportunity to evaluate the significance and value of education, via online involvement and gaming through the application of the entertainment factor. "…in an environment riddled with clutter, it is not easy to get the consumer's attention" [57, p.21]; so, the last, but not the least, is the use of novel and "atypical" content which enhances attention [62] via creation of unique experiences for the online audience [57, p.11].

4.4 The key stakeholders or "Generation Z"

Considering the extreme time-sensitive data on the stakeholders, the researchers include here the qualitative studies, invaluable for the digital data, conducted by "Google" [63, 64] on US teenagers born between the mid-1990s to early 2000s, ages 13-17. "Generation Z" ("iGen" or "Post-Millennials", those who are born after the "Generation Y") did not experience life without internet and are comfortable with using social media [65]. This generation indicates high dependence on technology [66]. Seventy-eight per cent of teenagers prefer mobile phones to other devices, followed by laptops, television, gaming, tablets, streaming videos online, messaging and social networking. Hence, developing mobiles and online videos should at least be considered. "…children already thinking about computer engineering and coding" as future professions. This fact could be reviewed by the HEIs when

planning courses. The study also aimed at the identification of “cool” through the eyes of modern teenagers, the aspects of their attention and excitement. This generation recognised that adverts influence their perception of "cool" products, particularly personalised ones. Unlike the “Millennials”, they “feel something is cool if it’s unique, impressive, interesting, amazing or awesome”. The definition has two conditions: (1) “just being yourself, embracing what you love, rejecting what you don’t”; and (2) “being kind to others”; while the product to be acknowledged as being "cool" requires three aspects: (a) “If friends are talking about it”; (b) “If I see an ad about it”; and (c) “If it's something personalized to me” [63]. These points should be targeted in digital marketing, e.g. via inviting prospective students being themselves, personalising the approach, as well as indicating gender differences in preferences [64]. It might also be useful to consider when planning a digital content strategy for an educational institution that this generation learned that traditional choices do not necessarily bring success. Sixty-one per cent of high school students wish to be an entrepreneur (not employee) and seventy-two per cent at this age already wish to have their own business. Money matters but social aspect is also considerable, as twenty-six per cent of teenagers, ages 16-19, are actively involved in volunteering and are socially concerned [67, p.14; 66]. Eighty-one per cent of teenagers perceive higher education as a necessity [68].

5.0 Conclusion and Recommendations

There is the demand for information systematisation, developing search engine optimisation and the relevant software on the UK Higher Education Institutions’ websites. Website users’ requirements have also increased, comparing any digital content and support not with competitors or similar companies, but with the best possible experience they have ever received online. This might be explained by daily-dependence on social media, technology and the information-overload the modern user encounters with in the daily life. These changes summon HEIs to re-consider their digital position to gain more significant and successful online presence. Researchers and practitioners suggest conducting research to attempt understanding and knowing the market and the users, as well as the need for organisations to adapt new ways of online engagement, new technology (particularly related to mobile phones) and creative approaches to content. The content creativeness and engagement are found to be the new ways of communicating marketing ideas. This is particularly sensitive for the digital data, as every piece of content on a website should lead to an action, i.e. to visit, to share, to purchase, to read, to discuss, to open, to donate, to fill in and so on. Social media and visual engagement are critical. Good quality content though is much more important, as it always takes the priority over any technology in the bigger picture. Some digital data generated by website users, so called user generated content, could also be highly beneficial with identification of the reasons for sharing, contribution and inspiring active online participants. Finally, the online data has to be strategically planned and organised, including the application of website metrics, as all online data must be measured, and the outcome should reflect the changes. Overall, digital content is the key and requires a professional approach to build and maintain relationships with the key stakeholders, ultimately, accomplishing the desired student recruitment. It is

highly recommended for HEIs to apply a digital content strategy model to content planning, creation and management for the approach to be holistic and successful. Apart from the obvious need for the content to be quality, there is a need to have processes and procedures in place to achieve the timely and useful content creation process, with assigned roles and responsibilities. “Opportunities and rewards… increasingly will be the product of creative thinking and thoughtful planning, not good fortune.” [61, p.3]

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The Five Stage Framework for Life Long Learning in Engineering Education and Practice

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Abstract

This paper examines and reports on a five-stage framework for lifelong learning in engineering education and practice. The paper draws on the authors' experiences in their universities and working with the local communities. The five stages are: Pre-employment (undergraduate stage, including the need for continuously updated CV); Early Employment; Mid-Career Employment; Later Employment (usually at the more senior level of the employment and preparing for up-skilling after retirement) and Post Employment (retired). The paper discusses and justifies, for each of the different stages, the appropriate activities such as involvement with professional societies, updating, both in breadth and depth, technical knowledge and soft skills, utilising SFIAplus or similar frameworks, the use of webinars and MOOCs, also the changing role of mentors, from mentee to mentor, throughout the stages. The involvement at various stages of related voluntary activities such as "giving back" to the profession are considered.

Keywords: Lifelong Learning, Professional Bodies, Networking Updating Skills, Engineering Education and Practice

1.0 Introduction

A framework for engineering education and practice has been created to meet the growing need for a clear definition of quality used in guiding curriculum development, classroom implementation, policy and standards in this current era of globalization. It is important that informed decisions guide the future about how engineering is implemented globally.

Engineering education and practice has been used to describe pre-college (secondary), university (higher education) and post-graduation (employment) knowledge and skills in society aimed at improving lives of individuals and communities. This, in recent times, has been integrated with STEM (Science Technology Engineering and Mathematics) subjects. STEM integration has the potential to provide learners with best opportunities. There is a natural interconnectedness of each of these four components of STEM in the real world of research and development, which affects students' interests and performance [1,2]. Engineering provides a way of meaningfully integrating STEM disciplines as it requires application of mathematics and sciences in the design and development of technologies, products and services for people and communities.

The authors use a five-stage framework to define and report on lifelong learning in engineering education and practice. The five stages comprise 1st Pre-employment (undergraduate stage, including the need for continuously updated curriculum vitae throughout the stages); 2nd Early Employment; 3rd Mid-Career Employment; 4th Later Employment (usually at the more senior level of the employment and preparing for up-skilling after retirement); and finally, 5th Post Employment (retired). The research examines issues of students, staff aspirations, the provisions of professional organisations and expectations right across the spectrum including employment and post-employment practice. The paper describes how the experiences of the authors and others identifies the five stages for lifelong learning based on their experiences in their universities and working with the local communities and professional organisations in the UK, Europe and Africa. This includes the innovations in teaching and learning and studying approaches developed and used.

With the constant change in engineering and technology of hardware, software, and applications, ranging from medical to cyber warfare, there is a constant need for professionals to maintain the currency of their knowledge throughout their lives [3,4,5]. This is required, not only by employers and individuals, but also by various professional institutions. This could involving maintaining an annual report, providing evidence to demonstrate their current skills and knowledge. These include an up-to-date CV documenting any CPD activities undertaken in the last year such as training courses and qualifications gained. The report could include examples of work based learning; professional activity, such as involvement in a professional body or mentoring; formal or educational activities such as writing articles or papers, or undertaking further education; self-directed learning such as reading journals, reviewing books or articles; other activities such as voluntary work or public service. In addition, the report for the Institue of Science and Technology also might

"provide examples of how your CPD has contributed to the quality of your professional practice and service delivery" and also in this report there is the request "to provide examples of how your CPD activity has benefitted the users of your work".

Some professional bodies ask their members to confirm, with the renewal of their membership, that their knowledge is current. This is normally encompassed in the Code of Conduct of the various professional bodies. An example of this is from the CIOB (Chartered Institute of Building) which states in its Code of Conduct [6] that "members shall keep themselves informed of current thinking and developments appropriate to the type and level of their responsibility. They should be able to provide evidence that they have undertaken sufficient study and personal development to fulfil their professional obligations in accordance with the current guidelines for Continuing Professional Development (CPD)". Similarly the Code of Conduct of the BCS [7] states that a member must "develop your professional knowledge, skills and competence on a continuing basis, maintaining awareness of technological developments, procedures, and standards that are relevant to your field" and "encourage and support fellow members in their professional development ".

There are many ways in which these skills can be updated, such as by reading journals, attending courses and conferences, but it is much more difficult to always provide evidence of the updating of relevant knowledge and skills that have been achieved, unless some form of assessment has been undertaken. The record of CPD whether paper based, or electronically held, such as with Open Badges [8], does at least provide a record of suitable attendance of up-skilling activities. The CPD activities can be provided in many different ways from traditional trainers to universities and colleges.The paper concludes with some recommendations with the note of the need to engage learners and employers in the lifelong learning process very early on in what has now become an ever-changing learning landscape of the globalised 21st Century.

2.0 Lifelong Learning and Engineering Education and Practice

Lifelong learning is a process of engaging in formal and informal education on an ongoing basis and ensuring that a person is equipped with the skills and abilities required to continue his or her own self-education beyond the end of formal schooling. In the past two decades since the turn of the 21st century, research on lifelong learning has accelerated as educators and policy makers globally are faced with the task of converting concepts into programmes. Lifelong learning has not only found roots during formal education but tended to go hand in hand in the creation of well-rounded engineers. Lifelong learning is a purposeful self-directed learning process that plays vital role in lives of individuals, through enhancing the quality of the learner's life and improving their economic standing. Engineering is the

discipline that helps build society. It is therefore important that institutions and government invest and provide lifelong learning opportunities and robust programmes that allows engineers and engineering professions to engage in lifelong learning throughout life.

The US Accreditation Board for Engineering and Technology (ABET) defines engineering as "The creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation or safety to life and property". It must be noted that engineering is best understood in relation to other disciplines [9,10]. Lifelong learning seeks to provide citizens with tools for personal development, social integration and participation in the knowledge economy**.** This should be applied across all levels of education and training and relates to all stages of life and must be reflected in strategies of governments, professional bodies and associated institutions to enable and make lifelong learning an integral part of the whole educational system, including the entire social and economic structure.

3.0 The Framework

This paper discusses the need for a five-stage framework, to encourage CPD being undertaken at all periods from college or university, through the various phases of employment, including post-employment period. With the increased life-expectancy, skills in this later stage could be important for a country's economy, for those engaged in paid or voluntary (unpaid) employment and particularly for local organisations and charities.

The content of the proposed framework could be related to career structures such as SFIAplus [11] for the computing industry. This provides, for all stages from the apprenticeship to the most senior level that might be a head of department, MD (Managing Director) or CIO (Chief Information Officer) of a large organisation. It identifies, for a range of specific employment roles, the various functions that might be undertaken, the skills and knowledge needed and potential qualifications. The range of skills needed, including the soft skills, change and develop as the career progresses and the awareness of the roles locally, within the company, country, and globally increase with the levels. This framework for lifelong learnibg takes a holistic view of the range of possible CPDs appropriate to the different stages of employment, such as can be applied to or adapted for all emerging disciplines.

3.1 Pre-Employment (Stage 1)

This is normally undertaken at a college or university. The majority of technology courses, especially those that are designed to satisfy the requirements of the relevant professional bodies, include the teaching of various issues of professional practice. This normally includes academic writing, with the correct use of references, relevant legal and ethical standards, and the need to develop and maintain throughout the students' future career, a CV (Curriculum Vita). This would include both the

academic skills and qualifications, as well as the relevant and non-relevant related experience, (such as working in a supermarket, volunteering for a charity), together with the students' interests. The students would be made aware that they must take responsibility to keep their CV up-to-date throughout their future career, and possibly beyond into retirement.

Students are often encouraged to attend, in addition to their course, lectures arranged by external bodies, such as the various professional bodies. Students are also encouraged to collect their CPD form as a proof of their attendance or, if a CPD form is not available, to make a record of the event including the title, speaker, general topic as well as the date, location and organising body. It is suggested that the students keep these CPD forms or their own equivalent details, either in paper form or as an electronic version, and to maintain these records well into their mid-career. These could prove to be useful for future reference prior to interviews, applications for employment or up-grading their professional status. Students are often encouraged to join the relevant professional bodies as a student member.

Some universities arrange for students to undertake professional qualifications or include these qualifications within the structure of the course. An example of this is the CISCO qualifications, often associated with networking undergraduate courses. These students, as part of their degree, would also achieve the externally recognised professional qualification. This is of benefit to the students as these professional qualifications enhance their CV, and also to their potential employers, who often understand the skills required by the professional qualifications in more detail than the actual content of a particular degree course.

By encouraging the students to undertake these additional external qualifications, these students understand that, regardless of the support or otherwise of their future employer, they can continue their accredited learning, possibly with a change of direction, independently of their employer if necessary. Students are encouraged to join events of the relevant professional institutions, and by attending regularly, they can increase their networking skills and possibly join a committee or a sub-committee, possibly as a student representative of a local professional group.

3.2 Early-Employment (Stage 2)

On starting employment, the planning and organisation of activities to add new skills and knowledge are usually controlled by the employer, often being initiated by a "need to know now" requirement for the particular employee. The employer will maintain usually through the Human Resource Department, a record of the training undertaken, but it is wise for the employee, especially in the early career, to maintain their own personal records. This would include both the formal and informal training received, as well as attendance at such activities as user groups, seminars, conferences and events of professional bodies. It is useful to also maintain on this "extended CV" details such as involvement in voluntary activities, which might include visiting undergraduate career fairs to represent their employers or their professional body or going to talk to school pupils about careers in the STEM sector.

Formal courses could be organised by the employer, varying from day release, to a few days or several weeks duration. These are highly structured, leading often to further assessment of the knowledge learnt. The employee, could independently of the employer, undertake a distance learning course, with possible occasional weekend or weeks attendance such as those organised in the UK by the Open University whose courses can lead to awards of an undergraduate or Master's degree. Remote study can be undertaken often at no or low cost by following an online MOOC (Massive Open On-line Course). These are usually provided by a number of well-known universities where assistance with the structured study material is provided often by online peer discussions between those following that particular MOOC. It usually has no recognised qualification for the attendees of these courses, unless they request this from the appropriate university and undertake assessments such as examinations, at a fee, organised by the university. Additional knowledge can be achieved by participating in online webinars, which are often free and can be accessed also after the event. By becoming actively involved in the discussions whether in the webinar or at a face-to-face event, this can help to improve the soft skills of the employee which will become even more important as they progress through their career.

During this period, the employee could become more involved with their professional body, both by regularly attending events, and possibly joining committees or sub-committees. This would increase the networking opportunities of the employee as well as possibly becoming aware of potential new job opportunities. They could utilise from the early career stage, the identification of the functions, skills and training from models such as SFIAplus [11] relating to progressing to the next level of their career. The employee can identify possible missing skills and at their next annual job appraisal meeting, are able to raise the need for suitable training. Otherwise the employee can undertake independent activities to add the necessary skills and experience. These should always be documented in an extended CV, and full records maintained of CPD undertaken. Early stage employees can be mentored by a more senior member of their organisation which would normally assist in their CPD and career progression.

During the early career, or even prior as a student, many decide, in addition to joining a relevant professional society, such as the BCS, The Chartered Institute of IT, the IET, the IEEE , the IST (Institute of Science and Technology) or the ACM. The range of membership is usually, Student, Member and Fellow, the latter only usually achieved towards the end of the mid-career or during later employment, as it is often dependent on level of responsibility, authority and experience. The advantages of professional membership are both the networking opportunities and the possibility to “give back” to the profession. This might be to encourage students, at school, college or university, to understand the applications and the opportunities in the STEM areas. It could be assisting with organising events, on being members of committees or on Standards Bodies, the latter might be towards the end of the mid-career stage or later stages.

3.3 Mid-CareerEmployment (Stage 3)

During this mid-career stage, the employee might undertake the role of a mentor to a new employee within the same organisation. However, the mid-career stage employee might wish to become themselves a mentee and have a mentor from outside their organisation at a more senior level. These arrangements are often facilitated by professional bodies for their members. The guidance from the mentor might be related to up-grading the professional membership status or applying to join county, regional or even national committees within or outside their professional body. The guidance from the mentor would suggest actions or activities to prepare the mentee for such roles in the future. The mentor could encourage long-term planning of the mid-career employee, including possible changes of direction and of employer. Proposals might be made to undertake additional technical or managerial qualifications such as the MBA (Master of Business Administration), that could be of advantage for current and future career levels. The mid-stage employee might consider participating in relevant MOOCs and webinars, in addition to perhaps speaking at conferences, and at local and regional events organised by relevant professional bodies. This would increase the networking opportunities; improve the soft skills, as well as the CPD. These activities would be of great benefit if the employee was considering becoming an independent contractor or consultant, where the external profile is of importance.

In the mid-stage of a career, in addition to professional membership, being normally at full Member or Fellow level, obtaining a Chartered status through the professional body can be considered. The three main ones are the Engineering Council's CEng (Chartered Engineer), the Science Council's CSci (Chartered Scientist) and the BCS's CITP (Chartered IT Professional). Many of the STEM institutions assist their members to obtain only one or two of these. In all three cases, the level of responsibility and experience is approximately the same, but there is a difference on the type of experience and qualification required for each of them. For the CITP, the candidate is expected to demonstrate a breadth and also a depth of knowledge in the relevant area, and a certificate of competence can be renewed every three years. For the CEng, the candidate is expected to maintain the currency of their knowledge. The CSci requires annual records of PPD (Professional and Personal Development), which can be audited every three years. The details regarding these records of the CPD activities can vary for the different institutions.

3.4 Later Employment (Stage 4)

At this point of the career, the employee could hold a senior position in their organisation and possibly in their professional body. The need to maintain current awareness of the changes in the profession, both current and predicted, is particularly important. The employee will be using the soft skills as a possible representative of their organisation or of their professional body on national or international committees, as speakers at conferences or being interviewed by the media. At this stage in the career, the employee or self-employed might become an external mentor to those in mid-career. The mid-stage employee could be participating as a panel member of a webinar or perhaps running a blog.

The employee might be participating in various voluntary activities, in preparation for the final stage of retirement. These might be becoming involved, possibly as independent governors of schools or colleges, or becoming involved with local centres where their technical and managerial expertise could be of value. In these cases, the employee could be "giving back" to the profession, by the voluntary use of their time, which still should be recorded in their CPD. In order to encourage the participation in these activities, the employee might consider becoming a "life member" of their professional body or of any other society of which they might wish to be involved with during their retirement.

3.5 Post Employment (Stage 5)

By maintaining awareness of the constantly changing technical developments and new potential developments in the engineering field, this can be beneficial to the retired employee as a possible action against dementia, lethargy and boredom. Continuing to "up skill" can be undertaken at little cost via short courses with or without qualifications, by participating in MOOCs and webinars. At this stage, the employee could, already from the later employment stage, be running or being a Chair or Panel member of a webinar. Further involvement, locally, regionally, nationally or internationally with the professional bodies can be welcomed as those not in restricted time constraints of employment are often of great benefit to a professional body and to voluntary organisations. The retired employee could become an unpaid lecturer for charities such as the University of the Third Age, as well as assisting as a visiting speaker at schools or colleges. The use of the TV and Internet can provide regular means for both entertainment and education for those in this 5th stage.

4.0 Benefits of the Framework

There are lot of benefits that can arise from the use of the current framework and stages identified. Its application at different levels could helped researchers assess usefulness with younger students in elementary or fundamental stages and settings, which would contribute to increase the understanding of how the framework could be useful in the classroom. It could inform development of curricula, classroom implementation, standards, and policy around engineering as we look towards how engineering currently is and should be implemented at different levels in the future.

The framework could be used to assess the status of STEM global academic standards and also how this is being applied to different national technical education in order to map and gain a picture of how technology is currently being represented in different educational systems [12,13,14]. There is the potential for the current framework to be used in developing units of instruction as well as for developing scope and sequencing throughout the curricula. It could act as a guide to ensure curricular units truly represent the complexities of STEM professional development and lifelong learning.

5.0 Diversity, Transdisciplinarity and Holistic Engineering Education and Practice

The embedding of inclusion and diversity in programmes makes for holistic engineering education and practice. It allows for trans-disciplinarity that is important for the development of future-oriented, sustainable and socially responsible engineers who are able to produce technical solutions and innovations that have societal and economic added value [15].The development and use of this technology in context for the provision of holistic engineering is crucial. It has been shown that programmes planned and delivered with features in the model enable students to become confident in working with different people, cultures and in different places [16]. This promotes understanding and encourages respect among learners in institutions and employees in the workplace, all of which increases the level of engagement, productivity and success and profitability. The needs of diverse groups are met. It encourages the development and adoption of best practice.

There are serious issues in putting lifelong learning into engineering education practice. One of them is the diverse nature of the educational system of each country, which is not yet prepared always to develop lifelong learning competences. This remains a major challenge to the many educational systems that have not changed their educational policies and pedagogical models to support lifelong learning. Another issue is the one of time constraints in the delivery of the various focused curricula across many educational settings. In Europe and USA this could correspond to Bologna and ABET frameworks directed at meeting the expectations of the rapidly changing and very different environments as implied by lifelong learning concept. There are others such as the BCS, the Chartered Institute for IT, the Institution for Engineering and Technology (IET), the African Engineering Education Association (AEEA), The European Society for Engineering Education (SEFI), the framework of The International Society for Engineering Education (IGIP) etc. This is an obvious indication that a change in education is needed. [17,18,19].

Such a change must be made up of educational processes that will strive for the capability of adapting, and even thriving in areas of new problems and new opportunities, requiring schools to look across disciplines, across the knowledge base of sciences, across the wisdom of the humanities, the verities and explorations of the arts, for the ingredients that will enable students to continually interact with a world in change, with the imminence of changes bringing essentially unforeseeable consequences [20]. The introduction of such a change has the potential to create a process that would result in collaboration among individuals and institutions from diverse disciplines and regions to develop and use integrated conceptual frameworks, tools, techniques and methodologies to solve common unstructured research problems relevant to industry and society.

6.0 Conclusion

Engineering education and practice engages in lifelong learning which provides opportunities to learn at the beginning stages and later extending into turning individuals into accomplished professionals and entrepreneurs [21]. In the context of lifelong learning, the teacher as a catalyst must turn knowledge into metaskills. This has the potential to meet the needs of learners in the twenty-first century, with reference to the development of individual capability, individualized learning and independent learning. The focus of the authors' research and the themes presented addresses issues concerning engineering education and lifelong learning, both of which require multidisciplinary approach involve fields from engineering, education, psychology and the world of work. The link between education, lifelong learning and employment is real and desirable. It is imperative that solutions are found not only for education but for practitioners and the world of work.

The five-stage framework for lifelong learning in engineering education and practice offers a collection of key indicators for a comprehensive engineering education at different levels and a means to develop those key indicators through systematic definitions of each indicator. The framework has potential as a research instrument that can lead to deeper understandings of learning and instruction in engineering education and impacts on the practitioners and industry. Further work ise in progress involving implementation of the framework in different parts of the world to include the UK, parts of Europe and Africa.

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Authors Index

Albinson P **43**
Al-husban M **129**
Ahmad S **129**
Anastasiadis T **117**
Bacon L **11**
Berki E **55**
Dewar E **69**
Gibb T **21**
Hooper LO **103**
Icke A **31**
Komisarczuk P **93**
Lampropoulos G **117**
Morrell C **81**
Morrell M **81**
Razina O **129**
Ross M **129, 143**
Sapounidis T **55**
Siakas K **117**
Tsimplinas A **55**
Valtanen J **55**
Uhomoibi J **103, 143**