INSPIRE XXIII

Technology in Education

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INSPIRE 2018

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PREFACE

This volume contains the edited proceedings of the twenty third International Conference, INSPIRE 2018 held at BCS, London, organised by the e-Learning and the Quality Specialist Groups 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 2018 has attracted papers from international sources, covering a broad spectrum of practical experience and research. The topic areas include making students more employable, learning analytics, learning environments and research supervision.

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We would like to thank the many people who have brought this twenty third 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 e-Learning and Quality Specialist Groups.

The organisers would like to thank the BCS and Southampton Solent University for their support.

The Editors

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Wood for Trees:
The Learning Analytics Voyage at the Solent

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The presentation depicted a perceptual picture of learning analytics based on the understanding of learners and teachers at the SSU as a case study. The existing literature covers technical challenges of learning analytics (LA) and how it creates
better social construct for enhanced learning support, however, there has not been adequate research on whether learners and teachers understand the significance of LA and how they can utilise it for enhancement of learning and teaching. This qualitative study helps to shape understanding of an LA initiative based on one university, but with implications for other universities. Shared stakeholders' understanding of LA with an institutional strategic priority supported by a collaborative delivery would ensure a successful implementation of LA.

Osama Khan is the Director of Learning and Teaching for Southampton Solent University. He is the founding lead of the new strategic unit – Solent Learning and Teaching Institute. He was also elected to the Board of Governors in November 2015 as a staff governor, and currently sits on the resources committee. Osama is a passionate teacher with 20 years' experience teaching corporate finance; real estate finance and investment; economics; mathematics for economics; derivative finance; and investment management. He has taught at renowned institutions including the University of Cambridge, University of Hong Kong, HEC Paris, and Copenhagen Business School. He is an avid advocate of technology enhanced learning, and has won multiple awards for his excellence and innovation in learning and teaching, including the University of Surrey Learning and Teaching Award 2010. More recently, he played a major lead academic role to inform the space design in the Spark project.

Keynote 2

The Potential Use of Smartphones for e-learning in Nepal and South Asia

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Abstract

During my fieldwork in Nepal, I became interested in the use of mobile phones, particularly in connection with e-learning and m-learning. With the rapidly increasing adoption of mobile phones within Nepal and other South Asian countries across all levels of society, this article builds on my fieldwork around literacy and explores current mobile phone usages and the potentials for m- and e-learning in the South Asian context. I will be examining both the practical elements of digital learning in South Asia and the theoretical and pedagogical aspects, before expanding on currently available learning tools and potential developments in smartphone use for both schooling and lifelong learning.

Keywords: Smartphones, e-learning, m-learning, Nepal.

1.0 Introduction

When I went to Nepal in the summer of 2017, I was counciled by friends and family alike (many of whom have never left Europe) that I should under no circumstances take my mobile phone out in public whilst in the country. I smiled and did not suggest they read Edward Said's work Orientalism [1]. Even with the knowledge the Nepal is a developing nation and not the moon, I was surprised by the widespread use of mobile phones, particularly as a device for connecting to the Internet. Even sat in the middle of rice fields miles from anywhere, the conversation between myself and the ladies participating in my research turned to

Facebook and how we could stay in touch. I had gone to Nepal with little if any real knowledge of the country, as a lot of the research I'd read had been written at the turn of the last millennium; what I found was a country undergoing a seismic socio-economic shift. The rapid uptake of smartphones is arguably supporting this shift, and my research data supported the importance of mobile phone technology.

With this in mind I began to investigate how smartphone technology could be used for educative purposes with a particular focus on lifelong learning and women's education.

2.0 Context – Nations Developing

My introduction rather flippantly pokes fun at the Western understanding of Nepal and South Asia in general, but it is worth stressing here the rapid development of Nepal and the continued development of India.

It would be easy to argue that these two countries cannot be compared: economically Nepal is one of the poorest countries in the world, India is one of the most rapidly developing; geographically Nepal is a small country whilst India is vast. However whilst there are huge differences between Nepal and India, there are some key reasons for the comparison and discussing these two countries together.

- Both have varying geography
- Both have a variety of religions with Hinduism being predominant
- Both have a variety of languages and dialects beyond the official languages

It is arguable that despite their differences India's development over the last 30 years could predict the development of Nepal. Whilst Nepal is currently one of the less economically develop countries in the world and is hampered in some respects by difficult geography, I would argue the Nepal is on the brink of rapid development and would not be surprised if in 10 years economists are writing about the new Asian Tiger. As India rapidly catches up and over takes former colonial powers, Nepal's trajectory looks bright.

As I move on to talk through smartphone use, it is important to keep in mind these trajectories of development and how far both countries have developed to date.

3.0 Smartphones

Smartphones are becoming ubiquitous across India and Nepal. In 2012 the Nepal Telecommunication Authority [2] reported that 61.8% of Nepalis had a smartphone, notably this figure is now six years old and the numbers have likely risen. Within

India, the Telecom Regulatory Authority of India reported in July of 2017 [3] that 1186.79 million people use a smartphone, covering the vast majority of the country's population. With the widespread uptake of mobile phones, particularly in India, this technology is no longer the sole domain of the upper classes.

Beyond the numbers there are a wide range of social aspects that smartphones support. One key aspect of smartphone use is rooted firmly in their intended use as a mode of communication. Amy North [4] writes extensively on the use of smartphones as a cause for the desire to learn literacy and as a key medium for global families to remain in contact. In her 2013 paper [4] she details how Nepali migrant women working in the UK used their phones to keep in touch with family both in Nepal and in other parts of the world. This was echoed in my own experiences - whilst I was only in Nepal for a short time I maintain contact with my friends and adoptive Nepali family through Facebook messenger. With large scale migration for work, particularly after the 2015 Nepal earthquake, mobile phones, and with them Facebook, have become vital in keeping global families and communities connected.

There is also a political aspect to the adoption of the smartphone; Sharma [5] in their study of Nepali teenagers in high-school found that one of their key uses of Facebook was to engage with political pages. This was echoed in my own research, which found that women who had become literate in adult life were engaging with politics, this coupled with the desire to learn to use computers to engage further, and it is easily arguable that ICT technology has the potential to drive political activism and change.

Smartphones have rapidly become a staple mode of communication, certainly in the part of Nepal where I was based. It is worth noting that Nepal differs widely between the Terai, Midhills and Himalayas reigons and between rural and cosmoplitan areas. Supplying education to these various regions is a complex process, and it as this point that I would draw your attention to smartphones as a source of education.

4.0 ME-Learning

It is useful at this point before discussing e-learning and m-learning in Nepal and India to address e-learning and m-learning in their own right. E-Learning has traditionally focused on digital learning both on and off-line, whereas m-learning focused more on the mobile nature of digital learning (hence the use of the m for mobile). If one can imagine the state of digital technology even at the start of the new millennium, the distinction between the two forms of learning made some sense, as mobile technology such as tablets, smartphones, lightweight laptops were not as ubiquitous as they are nearly 20 years later. I would argue that the time of e and m learning being separate has long since passed and it is now time to blend these two constructs into a new all encompassing principle. This then would

become the construct of ME-Learning, a theory of digital learning currently under development by myself and Daniel Hutty.

In its simplest form ME-Learning is less a pedagogy in its own right and more a skin to be applied to learning in a digital age. Arguably the fundamental way in which people absorb knowledge such as outlined in Vygotsky's theories [6] have not changed, it is the way in which knowledge is access and filtered that has adapted and changed. It is this change from a model of scarcity to a model of plenty, if not even a model of knowledge overload, that ME-Learning focuses.

ME-Learning focuses on a number of aspects which can be summarised as a focus on:

- Personalised – both in the sense of tailored learning experiences and allowing people room to explore and develop their own path through a set learning course. ME-Learning allows for adaptation for the learner and by the learner.
- Social – This is a slight misnomer in that social whilst built on interactions between learners must also account for the more introverted amongst us – the forum spooks who read the conversations but do not of necessity engage to a high level. ME-Learning principles must engage both the social butterfly and the spook within the learning design. The traditional "introduce yourself to the class" forum post does not work on a large scale and can put the spook off engaging with any of the learning topics.
- Online – Where e- and m-learning can be off-line ME-Learning is connected learning and this requirement for connectivity is a key difference from the parent theories.
- Mobile – Mobile in the sense of portable devices but also in the sense of flexible learning, such as time and place of learning. Also in the case of knowledge, building on the concepts of shelf-life of knowledge from Connectivism by George Siemens [7] and Stephen Downes [8], knowledge itself is mobile and as such knowledge changes and is flexible and the sources of knowledge are changeable and have the potential to be fluid.
- Educational – This might seem like an odd thing to list as a principle of a learning model, but in the age of edutainment the concept of what is educational must be addressed. Within the confines of ME-Learning the idea of educational is wide and is best described as that which allows the transference and retention of knowledge or skills to an individual.

The reason for discussing ME-Learning at this stage is to somewhat prime the mind of the reader to the various pedagogical aspects of smartphone based learning and to ask that they remain mindful of this style of learning as I discuss the potential educational uses of smartphone technology for education in Nepal in the coming sections.

5.0 Current Smartphone usage for digital learning

There are numerous initiatives working across India and Nepal to develop and support digital learning. I will focus on two projects here, the first is a study by Chudgar [9] looking into a smartphone project for literacy. The second is a weather application for farmers developed by the Nepal Development Research Institute.

In their 2014 paper Chudgar [9] outlined their research with 409 Gujarati-speaking adults, they conducted interviews to ascertain the potential for smartphone usage in literacy classes. In this particular study results were mixed, with only 30% of working men and 39% of non-working women desiring a mobile phone. This said Chadgar suggests that the female participants were receptive to learning through their phones as it engender flexibility. As such smartphone usage for women's education has the potential to work within the Indian context.

The second initiativeis an App currently being used within Nepal which is both educational and practical. The NDRI developed a pay-for weather App for farmers, the App enable them to more accurately predict the weather but also suggested how best to react to the oncoming weather. To support the App the NDRI conducted seminars on how to use the App and the benefits of the App with the end users. Following the pilot study the NDRI asked their participants if they wanted to continue using and paying for the App - the response showed that the majority of farmers were keen to continue usage.

In both cases smartphone technology was used for practical purposes, Chadgar's [9] participants were keen to learn how to use their smartphones to keep in touch and make phone calls, echoing my own findings and those of Amy North's [4]. Whereas the NDRI's weather app enabled farmers to increase their yield and work with the weather, enabling them to better prepare for events such as the annual monsoon. This focus on practical learning is something to remember when looking at the future of smartphone technology, and how to encourage learning that is applicable within the local contexts.

6.0 The potential future of Smartphone education in Nepal and South Asia

6.1 Schooling

During my time in Nepal I was lucky enough to meet two amazing children, PreetiandSanu, the latter was seven and the former eight when I met them. Watching them interact with technology was truly fascinating from an anthropological point of view. Preeti comes from a comfortably middle-class family and her parents lovingly say that they own a standby generator because Preeti cannot cope with being separated from the Internet. What was interesting

about this little girl was she could work her father's Ipad in three different languages – two of which she was not proficient in.

The second little girl Sanu, was born to very different circumstances; abandoned as a baby and left in the care of her 11 year old sister, she has mostly been raised by an aunt who lives nearby. Whilst I was visiting her elder sister I was on my phone and she climbed up into my lap, took my phone off me and said “Selfie”. Sanu could navigate her ways around complex apps on her sister's smartphone, and again could work in two languages – one of which she had little to no understanding of.

The reason for highlighting these two stories is that in both cases the girls had learnt how to navigate their technology without supervision or direct instruction - they have developed their skills with technology through intuition and exploration. The second point worth noting is that both children are girls, and traditionally gender has been an issue with the digital divide in developing nations (although there are notable exceptions such as Tanzania [10].

This then leads to the use of smartphones for schooling, now most Nepali six year olds do not have their own mobile phone and this must be remembered. That said, in both Preeti and Sanu cases they did have regular access to mobile devices. As such I would argue that educational homework Apps could potentially encourage girls' education and support learning in a system that has the potential to be overstretched at the point of use.

By developing gamified learning that works in tandem with children's schooling, learning is reinforced. In addition, one key criticism of the Nepali system is that children are taught by rote learning and do not develop critical thinking skills, which in turn leads to issues within the Nepali job market. Gamified, child-centric, student-centric learning tools could address this issue without having to wait for the complete overhaul of the education system to implement such a pedagogical style.

6.2 Naya Goreto

Naya Goreto (New Trail) is the literacy primer supported by the Nepali governement for literacy – and is predominately used for women's literacy. The course runs for six months and focuses on key words supported with pictures, building literacy confidence through a Freireian pedagogy [11].

Originally developed in the 1970s Naya Goreto had a number of issues from inception. Firstly the original plan was for there to be three versions of the primer (Terai, Mid-Hills and Himalayas), allowing for each to be tailored to the social context of each geographical region. Due to financial constraints only the Mid-Hills version was ever made [12]. Robinson-Pant [11] argues that through limiting the scope of Naya Goreto the social stories and the focus on social consciousness

raising is lost on participants from the Terai and Himalayas as they do not of necessity relate to the contexts within the Mid-Hills version of Naya Goreto.

I would suggest that Naya Goreto is a prime example of a pre-existing educational tool that could be supported and uplifted through the use of smartphones. The development of an application to support the hardcopy textbooks could lead to a number of benefits. Firstly, there is a large cost in updating the hardcopy teaching materials both for the Nepali government and the organisations that buy the books and tools and as such this has only happened once. Through using a low-cost application regular updates to the teaching materials could be made, allowing the teaching to cover more topical discussions, as was the tradition with the Freirian model of learning on which Naya Goreto is based [11].

Secondly, a key issue with women's literacy classes in Nepal is the drop out rate. Women, particularly women of lower economic and social status, undertake the majority if not all of the emotional and household labour. As such it is easy for them to be required to miss a lesson or two, and fall behind and decided that it is no longer worth attending. The use of an application which allows women to continue their studies at a time that is convenient for them would enable those women who have had to miss classes to remain up to date.

6.3 MOOCs

Whilst MOOCs have lost some of their hype since the bubble of 2012 they should not be overlooked in the context of South Asia. This subsection outlines a potential use of MOOCs within the Nepali context.

Certainly in Nepal there is an issue over schooling, in that the first 10 grades of school are free however the 11^{th} and 12^{th} are paid-for. Without the 11^{th} and 12^{th} grades it is not possible for a student to progress to university. This has the additional issue of effecting women and the less financially well-off, with parents often prioritising their male children over their daughters.

As such there is scope for NGOs and the Nepali government to work on very low cost or free MOOCs that would support students who had not been able to continue their studies. I would caution the mirroring of American MOOC providers' MOOCs, for several reasons. Firstly these tend to be Western-centric and as has been stated through this paper contextualisation is key. Secondly they tend to focus on videos which are data heavy, if it is taken that the bulk of the learning will be conducted on smartphones and not of necessity over wifi, then low data cost has to be a key criterion for a Nepal specific MOOC. Lastly, a stumbling point for MOOCs to date has been the verification and qualification aspect; at conception a Nepali MOOC must be builtaround with obtaining something meaningful at the end, such as a document that is recognised by universities.

MOOCs have potential and in developing MOOCs for the context of Nepal there is a lot that can be learned from the errors in the early days of the xMOOC and the

commercialisation of the concept. The development of MOOCs to date can form a bedrock for a Nepali MOOC but the constraints and context within which it will be used must form the core of any course developed.

7.0 Discussion

There is huge potential for smartphone use for educative purposes in South Asia, and further research is needed not only in Nepal and India but other countries within the region. However when working on smartphone technology there are a number of points that need to be addressed.

Firstly when developing smartphone based educational applications, particularly if one comes from a Western context, it is critical that the contexts are not taken either in an Orientalist framework or viewed as in a vacuum. With this the promotion of South-South collaboration I would argue is vital for innovative development. An example would be the introduction of a banking system to Nepal based on the African Mpesa. By exploring what is available already within the context of one developing nation there is the possibility of cross-pollination of ideas and systems to other countries.

A key point that must be remembered is that whilst there is huge potential for e-learning and, indeed, ME-learning, educational technologists do not need to reinvent the wheel and must be mindful of existing tool-sets and contexts. The outline for digitalising Naya Goreto is a prime example of how educational technologists can take pre-existing tools and adapt them to support different in-country contexts without having to completely redevelop a system and support the costs incurred in doing so; by working with what is already in place and working within a context and/or building upon it must be a focus for smartphone educative initiatives.

The last point to make in the section is one of quiet optimism - whilst it is critical to acknowledge the issues and difficulties within the context, this is not to become stuck dwelling on problems. Whilst I would council anyone who states smartphones will revolutionise education in Nepal or India, that technology alone will not change the status quo, I would say that approaching the problems practically and referring to how, exactly, an initiative would working within the confines of the issues at each stage of the design could help overcome a number of stumbling blocks.

8.0 Conclusion

"This is the computer age. Computer is required to do everything."
(Kesari - organic farm group (originally in Nepali),
from my MA dissertation research into women's literacy [13])

As smartphones become both more powerful and more available this message become truer and truer. As South Asia continues to develop at increasing speeds the way technology blends with education must become a focus for all educators. Particularly as women, people of lower castes and young people gain more access to technology, it is vital to address the potential of this technology in supporting and promoting their education.

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Papers

Social and Ethical Issues that should inform the Development of Legal Principles concerning matters of Intellectual Property Rights in the Development and use of Virtual Learning Environments

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Abstract

It is widely recognised that technology offers a chance to redefine, or at least change, learning and education for the better. A virtual learning environment (VLE)isa Web-based platform for the digital aspects of courses of study. They are typically deployedwithin educational institutions, especially in Higher Education (HE).

The development and utilisation of learning and teaching materials for online education in HE raises, amongst content developers, providers and consumers, a number of issues, one being intellectual property rights (IPR). The law, i.e. legal principles, can guide developers and consumers, with regards to recognising their legal duties and rights concerningIPR related to the field of VLEs.

It is generally recognised that law and morality do have in common certain key principles and obligations. Thus the law will clearly apply and lead directly to the appropriate ethical conclusion. However, to rely solely on law as a moral guideline is clearly dangerous because in certain circumstances bad laws exist. Inadequatelaws may bind rules on society that fail to provide moral guidance. Such laws may, in some instances, excuse a society from fulfilling certain obligations and duties, or allow a society to justify their unethical behaviour.

In this paper we present ethical principles, sourced from ethical theories that can be applied in the debate concerning IPR. In addition, we present philosophical works, from both western and eastern philosophies, which also address questions invoked by IPR.

In doing so we flag possible instances, where intellectual property right legislation fails to provide moral guidance.

In the design and use of VLEsin HE,developers, content authors, tutors and learners must be aware of these ethical and philosophical concepts, as presented in this paper, in order to become more responsible professionals and citizens in general. Law makers must also be aware of the identified shortcomings, where the relationship between law and ethics breakdown, in order to draft and/or amend respective legislation.We propose a set of heuristics for development/amendment of IPR legal principles that provide for moral guidance.

Keywords: virtual learning environments (VLE), ethics, intellectual property rights (IPR).

1 INTRODUCTION

1.1 VLE

A Virtual Learning Environment (VLE) is a system for delivering learning materials to students via the web [1]. The key components required for online education curricula, include: content management; curriculum mapping and planning; learner engagement and administration; communication and collaboration; and real time communication [2].

1.2 Intellectual property

According to the United NationsPatent Office, the World Intellectual Property Organisation (WIPO)[3] intellectual property is defined as:"*The rights to, among other things, the results of intellectual activity in the industrial, scientific, literary or artistic fields".*

WIPO divide intellectual property into two categories. The first category is defined as *industrial property*, which includes the following intellectual objects: inventions (protected by patents), trademarks, industrial designs, and geographic indications of source. The second category is defined as *copyright*, which includes the following intellectual objects: literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs.

Characteristics of Intellectual Property

There is a distinction between physical and intellectual objects. Intellectual objects are defined, as being *nonexclusive* because many people can use them concurrently

and their use by some do not prohibit their use by others. Another characteristic of intellectual objects is that their development may be a protracted and costly affair [4]. However, computer ethicists argue that the marginal cost of providing additional access to intellectual property is usually negligible.

Intellectual property rights imply that someone has the right to certain concepts, knowledge, or information. However, this invokes a serious issue of whether protection should be granted to ideas. It could imply that if one has property rights on an idea it could potentially mean the right to exclude others from using and building upon those ideas. This issue is resolved by copyright protection extending only to the expressions, and not to ideas, procedures, and methods of operation or mathematical concepts as such.

All of these characteristics make intellectual property rights more difficult to define:"*Justly so, especially in open democratic societies that prize free expression and the free flow of ideas. Assigning property rights to intellectual objects seem antithetical to many of the goals and traditions of a free society. Thus those who oppose strong copyright protections often appeal to the First Amendment, along with the need for maximum vitality in the marketplace of ideas as a rationale for their opposition*"[4].

The aim of this sectionis to present the diversity in opinions over the argument as to why intellectual property should be protected versus the idea of relaxing / abolishing protection, by presenting a selection of ideas and allowing the reader to decide which viewpoint they agree with most closely.

1.3 Computer Ethics

Salient questions such as: ownership of created digital materials and content posted online; the institutional or organisational limits of ownership to an author's e-materials and digital products; and the right to use content, belonging to other organisations that is found on the worldwide web; help flag ethical concerns regarding the development and use of VLEs.

Ethical judgments simply do not have the same deductivity and objectivity as scientific ones. However, moral judgments should be based upon rational moral principles and sound, carefully reasoned arguments. Normative claims are supported by:

"*An appeal to defensible moral principles, which become manifest through rational discourse*" [5].

Thus, with regards to the ethical issues raised by the development and deployment of VLEs, in Section 2 of this paper we will present a list of *defensible moral principles*. In Section 3 the authors identify the current issues concerning copyright and virtual learning environments from both academic staff and student perspectives. The philosophical arguments for the relaxation of intellectual property rights are articulated in Section 4. A number of heuristics are suggested in Section 5, which if followed may lead to ethical IPR guidance. These normative claims are substantiated via the citation of one or a number of the ethical principles

from Section 2 and/or one or a number of the philosophical arguments listed in Section 4. Thus each heuristic is based upon rational moral and philosophical principles and sound, carefully reasoned arguments.

2 IPR: ETHICAL PRINICPLES AND PHILOSOPHICAL STANCES

2.1 Ethical Principles

There are a plethora of ethical theories that have been developed throughout history and one or a combination of these can be selected. Fundamentally there are two basic approaches to ethics: *Teleological* theories (consider the consequences of an action as a measure of goodness) and *Deontological* theories (emphasise the rightness of an action above the goodness it produces).

Kallman and Grillo present a framework for ethical analysis [5]. Amongst, a multitude of other details, it lists some basic moral principles and theories that can serve as normative guidelines for addressing the moral issues, cases where ethical and professional issues may have been invoked. The framework also advocates the steps that are required in order to conduct an ethical analysis.The following sub-sections enumerate these principles that have been sourced from ethical theories, including Teleological and Deontological ones.

2.1.1 Deontology

Duty Based Ethics (Pluralism) can be viewed as seven basic moral duties, which are [6]:

1. One ought to keep promises (fidelity)
2. One ought to right the wrongs that one has inflicted on others (reparation)
3. One ought to distribute goods justly (justice)
4. One ought to improve the lot of others with respect to virtue, intelligence, and happiness (beneficence)
5. One ought to improve oneself with respect to virtue and intelligence (self-improvement)
6. One ought to exhibit gratitude when appropriate (gratitude)
7. One ought to avoid injury to others (non- injury).

According toKallman and Grillo in Rights-Based Ethics (Contractarianism) there are three fundamental rights. Hamelink identified, and appended, a further seven to give the following list of rights [7]:

1. The right to know
2. The right to privacy
3. The right to property
4. The right to security
5. The right to political participation

6. The right to freedom of expression
7. The right to freedom of association
8. The right not to be discriminated against
9. The right to fair access to, and development of, communication resources
10. The right to protection of cultural identity.

2.1.2 Teleology

The three philosophies under the umbrella of teleology are [5]:

- **Ethical Egoism**: Moral agents ought to do what is in their own self-interest
- **Utilitarianism**: Operating in the public interest rather than for personal benefit; maximises benefits over costs for all involved, everyone counting equal
- **Altruism**: In benefit for others, even at a cost to yourself.

2.1.3 Further Normative Principles

- **Principle of Autonomy**, According to Immanuel Kant's moral philosophy, for an individual to be truly human, that person must be free to decide what is in his or her best interest [8]
- **Principle of Informed Consent**: The Kantian approach affirms that someone has given agreement freely to something. For such an assent to have significance, it should be informed, that is, based on accurate information and an understanding of the issues at hand. If this information is deliberately withheld or is incomplete because of carelessness, then the consent is given under false pretences and is invalid [8].
- **Golden Rule**, *"What you do not want others to do to you, do not do to them.*"
- **The US Content Subcommittee of the ImpactCS Steering Committee**[9]: Quality of life; Use of power; Risks and reliability; Property rights; Privacy; and Equity and access.

The appropriate and respective normative principles presented above will be applied to themoral dilemmas that are invoked by the development and deployment of virtual learning environments by VLEs developers, content authors, tutors and learners.

2.2 Philosophical defences of IP protection

Intellectual property is viewed as an old but dynamic concept. The origins of the state granting forms of exclusive rights for inventions to their respective inventors originated in the early part of the 15th century in Venice. This spread rapidly during the 16th century across Europe to Germany, France, the Netherlands, and England.

It was early recognised that in a free market economy, patent protection provided:necessary incentive to invent, to disclose the invention, to invest in the commercial development of the invention, and to motivate others to add to the

store of human knowledge by designing around the patented invention. Copyright laws provide authors the benefit of economic rewards, while the public receives the benefit of literature, music, and other creative works that might not otherwise be created or disseminated.

Spinello presents a select few [10]:

- **John Locke (1632-1704):** argued that if one mixed one's labour with something then one had legitimate claim to it. Locke did, it must be said, place some restrictions on the right to appropriation. There had to be, for example, "*enough and as good left for others*".
- **Hegel (1770-1831):** argued that property was an expression of a personality. A rationale for why the ownership of the end product should be claimed by its creator is that these products represent an expression of the labourer's personality.
- **David Hume (1711-1776):** private ownership is necessary as an incentive to work. Ownershipencourages"*useful habits and accomplishments*".
- **James DeLong:** unless we have clear ownership rights, and unless we pay for the goods (i.e. property) that we need, the result will be greed and chaos. In other words, free goods become devalued and abused.
- **DeserveArgument:** A producer or creator deserves reward for his orher production or creation. If I create something I deserve something in return for my effort.
- **The Utilitarian Argument:** The generation of new ideas is necessary for society to prosper. It can be time consuming and costly to generate and develop ideas, so there must be some reward for those who do. Otherwise society's supply of new ideas will dry up.

3 CURRENT ISSUES PERTAINING TO COPYRIGHT AND VLE

The copyright of the learning material which is used and shared with students, via a virtual learning environment, must be taken into serious account. If not then there is the possibility of contravention of UK copyright law.

3.1 Academic Staff Perspective

In HE learning materialsare typically originated by a member of staff acting in theirprofessional capacity. They include: validation requirements and course documents, lectures and open distance learning materials, syllabuses, teaching schemes, annualreports, course handbooks, course publicity materials, records and documentsdeveloped for examination and assessment purposes, and work specificallycommissioned by the HE institution in any format [11]. Material that has been produced, not previously published commercially, can be freely uploaded to a VLE or the wider Internet for the purposes of teaching. However, in instances where the work has been published commercially, then the publishing agreement must be consulted. This will outline what is permissible in terms of distribution.

There is a salient distinction that needs to be made between a *creator* and a *copyright owner*.The copyright owner is usually the creator (or creators where there is a joint collaboration). However, more often than not in HE the work is created as contractual requirement of employment.Thus University will retain its rights to ownership of all IP if it was created in: the course of the employee's normal duties; inthe course of duties specially assigned to the employee; or it was made, without special payment or arrangement by the employee, usingconsumable resources of the University.In another instance where the creator may not hold the copyright is when it has been sold, contracted or assigned to another person/s or organisation/s [12].

Under the *fair dealing* provision of the Copyright, Designs and Patents Act 1988 (CDPA) [13] for illustration for instruction, lecturers are sanctioned to reproduce and use brief or short extracts from literary and musical works, films, sound recordings and broadcasts as well as artistic works to illustrate or reinforce a teaching point in lectures and in restricted intranets such as Moodle, provided the original source is explicitly acknowledged.

Fair dealing is a legal term. It is used to establish the legality of using copyright material: whether it is lawful or it infringes copyright. In the UK there is no statutory definition of fair dealing. Thus its determination will always demand a judgment to be made, i.e. it will always be a matter of fact, degree and impression in each case. In order to be considered fair dealing the use of copyright material must not adversely affect sales of the work and where the amount copied is reasonable and appropriate to the context.

Thus, a select few scenarios in lecturing:

- A Lecturer takes a clip from DVDs or from a website and uploads to aVLE for students to access and use as part of their learning
- A Lecturer includes images, such as photographs of works of art, in a PowerPoint presentation and uploads to a VLE
- A Lecturer uploadsa copy of one article from a subscribed e-journal toaVLE
- A Lecturer incorporates copyright material in a PowerPoint presentation and shown in a live lecturesubsequently uploads ittoa VLE
- A Lecturer includes third party owned material in a lecture recording, which is subsequently uploaded to a VLE
- The VLE provides access to copyright materials to overseas students.

Section 32 of the Copyright, Designs and Patents Act (CPDA) 1988all forms of copyright works can be copied for the purpose of *illustration for instruction*. This

includes: broadcasts, sound recordings and artistic works, to illustrate a teaching point. The exception is subject to fair dealing, as outlined above.

With regards to the above scenarios below are some salient issues that must be taken into account:

- The purpose of using copyright work must be limited to illustration for instruction, i.e. to illustrate a teaching point; a non-commercial educational purpose.
- Copying is deemed fair in that it does not negatively impact on the market for the original work and upholds the rights holder's ability to commercially exploit their work
- The useof copyright work must be non-commercial and sufficiently acknowledged.
- Restricting access to the learners who are enrolled on the particular course will support the contention that use is fair.The material made available under the illustration for instruction exception must be scanned and uploaded to a password-protected intranet (e.g. VLE); and not be made available on publicly accessed websites such as Faculty or Departmental websites, in social media and so forth.
- Images, e.g. photographs of works of art may be used as long as the purpose is for illustration for instruction and the images are provided in low-resolution.
- Under Section 30 of the CPDA fair dealing is permitted for the purpose of criticism or review. The criticism or review exception applies only to works that have been published.
- If the amount copied exceeds what would be fair then the institution would have to rely on their Copyright Licensing Agency (CLA) licence to copy materials and place them in the VLE. In doing so they would have to reference the CLA licence accordingly.Works not subject to the CLA could be copied and incorporated in the VLE under Section 36 CDPA provided the amount copied does not exceed the limit of 5% of a work in any period of twelve months.

3.2 Student perspective

Many educational institutions will have a code of conduct that covers many aspects engaging with a VLE, including copyright. Typically the copyright of the study material and all other content of a VLE are owned or controlled by the institution. They will permit their students to view, copy, and print documents within this VLE subject to their agreement that[12] [14]:

- Your use of the material is for your own personal information and for non-commercial purposes only.
- You will not modify the documents or graphics in any form or manner.
- You must remember that just because something is in the public domain doesn't mean you shouldn't cite it. Always give proper credit to your source.

- You will not copy or distribute graphics separately from their accompanying text and you will not quote materials out of their context.

4 PHILOSPOICAL DEFENCE FOR THE RELAXATION OF IPR

The availability of a vast and diverse body of knowledge, data and practical experience serves as a critical input for future innovation. A wider and equitable distribution of various types of knowledge can spur innovation substantially [15].

By no means an exhaustive list, however the following are a select few philosophical arguments, which reason for the relaxation of Intellectual property rights:

- Fundamental Flaw in Locke's Theory: why we should gain what we mix our labour with, rather than simply losing our labour. Weckert illustrates this point [16]: "If I poured a can of tomato juice, which I owned, into the sea, clearly I would not thereby own the sea. I would merely become juiceless".
- To What Extent is a New Idea Really Yours? Is an idea solely attributable to one individual? To what extent is the new idea, a creation, really mine? The renowned English scientist and philosopher Sir Isaac Newton wrote in a letter to Robert Hooke, (referring to his scientific discoveries): "*If I have seen further it is by standing on the shoulders of giants*".
- Equity and Access: By placing a monetary value on intellectual property, owners are controlling who can use, enjoy and benefit from its utility. This invokes the fundamental ethical issue of equity and access [4].
- Marxism and Scientific Socialism: The ownership of intellectual property is akin to the ownership of the means of production. Those owners, the haves, of IP have the power in controlling who can use, enjoy and benefit from its utility. If the have-nots can seize control of intellectual property perhaps society can be established, where the use, enjoyment and benefit that intellectual property offers will be equally shared.
- Reinventing the Wheel: Open source code software is based on the premise that collective programming wisdom creates better quality software in comparison with any single individual or group of individuals working within a company could construct. Because the ownership of programs is so obstructive and yields such negative consequences, this practice should be abolished [17].
- The Utilitarian argument: To say that the source of new and innovative ideas would dry up without copyright and patent protection to facilitate financial reward is little more than an article of faith. Artists, academics and scientists frequently create without such reward.
- Plato [18]: With regards to the rules on ownership of land (property), Plato postulates four property classes. Members of the first class have assets with a value between three and four times the worth of the lot (and the resources needed to farm it), the second class between two and three

times this value etcetera. Anything accrued over the uppermost amount will be seized by the city. Thus there is quantifiable cap on ownership (property/capital), a ratio of 1:4 between the fourth and first property classes.He does not advocate equality just moderation of the extremes.

5 HEURISTICS FOR DEVELOPMENT OF ETHICAL IPR GUIDANCE

A number of heuristics are suggested below, which if followed may lead to ethical IPR guidance. Each rule of thumb is substantiated by citing one or a number of the ethical normative principles, listed in Section 2 and/or philosophical stances, presented in Section 4 above. It should be noted that some of the heuristics may not be defended by existing legal principles.

1. If an institution places responsibility on an instructor to ensure that information provided within a teaching environment is protected then the former has a duty to offer training. This may take the form of general awareness training, basic and operational training on best practice concerning copyright and VLE. This should also be a component of continued professional development and teaching fellowships.
    - ***Deontology, Pluralism:Beneficence***
    - ***Deontology, Pluralism: Non-Injury***

2. If a HE institutionretains its rights to ownership of IP that has been created by an employee, of material that has not been previously published commercially, then the institutionhas an imperative to respect universal access to education. Thus such material should not only be uploaded to a password-protected intranet VLE or the wider Internet for the broader public consumption of the knowledge contained within.
    - ***Deontology, Pluralism: Justice***
    - ***Deontology, Pluralism: Beneficence***
    - ***Deontology, Contractarianism: The right to fair access to, and development of, communication resources***
    - ***Teleology: Altruism***
    - ***The US Content Subcommittee of the ImpactCS Steering Committee: Equity and Access***

3. Education providers have a duty to instruct/inform their students of the legal issues concerning copyright and VLEs.
    - ***Deontology, Pluralism: Beneficence***
    - ***Deontology, Pluralism: Non-Injury***
    - ***The US Content Subcommittee of the ImpactCS Steering Committee: Risks and reliability***

4. Education providers have a reciprocal duty to instruct/inform their students of the social and ethical issuesconcerning copyright and VLEs.

These may, more often than not, conflict with what the law demands. Educators must articulate to learners a full and accurate understanding of the issues at hand before demanding learners to agree to terms spelt out in, for example, a code of conduct that adheres to legal requirements.

- ***Deontology, Contractarianism: The right to Know***
- ***Principle of Informed Consent***

5. The CLA License that an education institutionpermits staff to scan specific percentages of copyright materials. For example, one chapter of a book or no more than 10% of the book, whichever is the greater; or one article from a journal or no more than 10% of the journal, whichever is the greater of Informed Consent; etc.The following ethical normative principles and philosophical stances maybe cited to argue/defend larger percentages of copyright material to be reproduced and placed on a VLE:
    - ***Deontology, Pluralism: Justice***
    - ***Teleology: Altruism***
    - ***The US Content Subcommittee of the ImpactCS Steering Committee: Equity and Access***
    - ***Philosophical stance: To What Extent is a New Idea Really Yours?***
    - ***Philosophical stance:The Utilitarian argument***
    - ***Philosophical stance: Plato, Laws***

6. Educators have a duty to provide students with skills, strategies and information specific to online environments.Digital competence should be one of three cross-curricular responsibilities, alongside literacy and numeracy.Learning Wales Digital Competency Framework is one such example which includes elements such as digital rights, licensing and ownership in the context of citizenship; interacting and collaborating; producing; and data and computational thinking [19].
    - ***Deontology, Contractarianism: The right to Know***
    - ***Deontology, Pluralism: Beneficence***
    - ***US Content Subcommittee of the ImpactCS Steering Committee: Equity and Access***

7. HE institutions should provide critical infrastructure and funding for the development and maintenance of mirror websites that are replicas of VLEs hosting to near as possible identical content, where any copyrightable material is removed in order to promote universal access.
    - ***Deontology, Pluralism: Justice***
    - ***Deontology, Pluralism: Beneficence***
    - ***Deontology, Contractarianism: The right to fair access to, and development of, communication resources***
    - ***Teleology: Altruism***

- ***The US Content Subcommittee of the ImpactCS Steering Committee: Equity and Access***

8. The Free Software Foundation advocate Copyleft, a licensing strategy, which is a general method for making a computer program, or other work, free (in the sense of freedom, not "zero price"), and requiring all modified and extended versions of the program to be free as well [20]. Educational institutions should look to, collectively, formulate a similar licensing agreement for teaching material where the material is free in the sense of the freedom to access it; to study and change it; and to redistribute copies with or without changes.
    - ***Deontology, Pluralism: Justice***
    - ***Deontology, Pluralism: Beneficence***
    - ***Teleology: Altruism***
    - ***The US Content Subcommittee of the ImpactCS Steering Committee: Equity and Access***
    - ***Philosophical stance: Reinventing the Wheel***
    - ***Philosophical stance:The Utilitarian argument***

6 CONCLUSIONS

The rationale of applying the ethical framework developed by Kallman and Grillo was to identify and defend ethical stances that can be takenin the concerns overIPR andVLEs.In doing so, the authors conclude that the importance of ethical considerations in the use of virtual learning environments in education can be bought to the attention of the VLE community: providers, learners, creators and owners, thus help raise the visibility of ethical use.

The paper contributes to the current ethical and philosophical discourse relating to the sustained growth of VLEs in education. In particular, a set of heuristics for the ethical IPR guidance has been proposed which will raise awareness of the moral issues and help guide developers and consumers (students) of VLEs.

The development of a set of heuristics for ethical IPR guidance presented this paper is an important one.For some of these suggested rules the law clearly applies and leads directly to the appropriate ethical conclusion. However, some of the heuristics, although ethically and/or philosophically defended, via the citation of respective principles, cannot be legally upheld. But to rely solely on law as a moral guideline is clearly dangerous because as highlighted by Wagner four possible states exist in the relationship between ethics and law [21]. Wagner's taxonomy identifies four possible states which depend on whether a specific act is ethical or not ethical, and legal or not legal.

Table 1, above presents these states. This implies that in certain circumstances bad laws exist that fail to provide ethical guidance.

Table 1: Legality versus Ethicality

	Legal	Not Legal
Ethical	*a*	*b*
Not Ethical	*c*	*d*

a = An act that is ethical and legal
b = An act that is ethical but not legal
c = An act that is not ethical but is legal
d = An act that is not ethical and not legal

The BCS, The Chartered Institute for IT, presents in its Code of Conduct a set of tenets of professional conduct [22]. Professional responsibility 2 d) states: "*ensure that you have the knowledge and understanding of Legislation and that you comply with such Legislation, in carrying out your professional responsibilities*". On the basis of the arguments presented in this paper that bad laws, statutes and regulations exist then it is imperative that the Code of Conduct is amended to include a statement that members shouldbe expected to exercise their own moral judgement (which should be arrived at through a judicious, reasoned, methodical manner using universal ethical normative principles) and that if the outcome contradicts the requirements of the Law then they should seek advice. For professionals to blindly comply with all legislation, regardless of whether the law is ethical or not, is not justifiable.

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The Messiness of Human Life in Technology for Education

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Abstract

Calm mathematics and rational logic aren't often the drivers of human behaviour. In any classroom setting where technology is used, a teacher will necessarily have to communicate in a way that is intelligible to the machine. The software was developed with the aims of clarity and predictable functionality in its design. But this may be opposing to the many small, chaotic engagements which are part of the vibrant and multi-actor context of a classroom. The chasm between the desired determinism of technology for education and the constructivist, interpretive stance of its end users does not necessarily constitute an insurmountable conflict. Instead of trying to simplify the messiness of human life, it can aim to accommodate and complement its strengths. It is an opportunity for partnership, and technology can be developed in a way that supports a different human-machine relationship – one which is less time-consuming, more compatible, and better suited to the teaching and learning environment. In revisiting the original idea of man-computer symbiosis, this paper explores an alternative place for technology in education, and a different aim in its development – from tool to partner.

Keywords: technology determinism, constructivism, user context, human-computer interaction, teachers

1.0 Introduction

Good software design does not begin with programming. The latter constitutes the hands-on coding effort which is required to makes programmes execute specific functions, and also function as a whole. Instead, software development begins with a step back to look at the design, its implications, its user context. The end users are simultaneously the target and the biggest challenge in the process. The

irregularities of human thinking demand software processes to take into account details and exceptions which were not included in the careful arrangement of the code. In her fictional book *Close to the Machine*, software engineer Ellen Ullman describes how the original coding of a programme has the beauty of a crystal, 'a cut-diamond-like state of grace' [1], until it meets the human context.

When technology enters the classroom, it meets a world of real people interacting in often unpredictable, regularly irrational, and – to the machine – chaotic ways. The classroom is a high-stakes environment for all involved; the teachers (considered here as primary users of the intended technology), students, their parents, the school, the community, the governors, … Indeed, the company providing the classroom technology benefits from the school's success too in their marketing effort. It has to go well. By all means intended, the technology is designed to work. Yet often it doesn't – going from malfunctions, to alternative uses, to disuse, as described by Larry Cuban's *Oversold & Underused: Computers in the Classroom.* In this book, the author describes how technological determinism promised to revolutionise teaching and learning in the American education system. Despite availability and access, that didn't happen. More recently, Cuban admitted surprise as to the increased frequency of use; but maintained the central tendency in the use of classroom technology was still of a superficial nature [2]. Although Cuban does not fully commit to one explanation, he considers the context of use as key. Lack of time and lack of training have been identified in many studies as two influential factors [3]. The issue of time amongst other such things of human life was also evidenced in an extensive UK study on secondary school teachers using digital language lab technology, which this paper uses as its inspiration. The intention of the study was to investigate technology acceptance behaviour. It shows the dynamics of the human context is key to understanding the adoption, continued use and improvement of a software in an educational setting. It particularly highlights the chasm between the desired clarity and determinism of software development; and the constructivist, interpretive stance of its end users. 'What begins in grace soon reveals itself to be a jumble.' [4]. Various software improvement processes are already in use to accommodate the unpredictability. Yet the conflict seems to persist regardless; which gives rise to an alternative, and arguably more fruitful approach.

Often, new solutions are found in conflict. This paper revisits the ideas of the visionary internet pioneer, Dr. Joseph Carl Robnett Licklider, or as he preferred to be called; 'Lick' [5]. He was one of the people setting the course for the early ARPAnet project, preceding what is now known as the internet, which provides the foundation for the world wide web. In the early sixties, when only a handful shared computers were in existence, he describes this idea of a much bigger network, humorously calling it 'the intergalactic network' [6]. In this interview two years prior to his passing, he expresses his frustration with the time it takes to develop and implement a vision. He will have been aware of the initial stages of technology in the classroom, just like the initial spread of personal computing. But the full realisation of the possibilities he envisioned was not for his lifetime. His writing includes many ideas for future developments, some of which have been realised

and some haven't (but are realistic prospects today), but all of it is taking longer than he predicted. In 1960, he published a paper titled *Man-Computer Symbiosis* to the Air Force Office of Scientific Research. In this text, he proposes that humans and computer technology engage in a much more cooperative interaction. Rather than the computer being a tool to a person, both entities engage in a partnership of equals, each with their own merits, but interdependent. It is not unlike to, but still distinct from, the more commonly used concept of the 'cyborg'. This concept holds great potential for education, but it is largely unexplored in education studies or educational technology development. It may be partly due to misunderstandings of the theory, further confused by popularisation in public media. In any case, Licklider expected his ideas to be realised within decades after his writing, and felt it would be 'intellectually the most creative and exciting in the history of mankind' [7]. Adopting his vision in the development of technology for education could go a long way in overcoming the typical struggle of programmers, and the frustrations of end users.

2.0 Using Technology in the Classroom

Actual use of a technology can be quite different from its intended use, as Larry Cuban observed in the US. In the UK, factors like the prevailing exam culture, inspection regimes, and issues around job performance were found to be significant influences on the use of a very particular classroom technology [8]. Modern-day classrooms are expected to make use of technology, but this did not mean to use technology in a particularly advanced way. Like Cuban concluded, playing it safe was often preferable to risking potential failure. The context of use is too crucial both in its purpose of learning as well as the omnipresence of observational measures to judge quality of the educational provision. The logic adopted to use technology in the classroom was not one particularly inspired, or helped, by the system design characteristics. The technology, much like any other tool, was regarded as one element within a larger framework of meaning and human purpose which is only partly explicit, and to a great extent socially constructed.

The factor of time in particular is hard to overestimate. In the study from which these conclusions are drawn, it was a dominant factor both in the qualitative data as well as statistically significant in the quantitative phase. Time is in itself a good indicator of how different computer logic and human reality really is. To people, time can fly by, or slow down. Seconds can feel like minutes, while hours can feel like minutes too. Fridays are more exciting than Mondays to some people, while January constitutes a time of new beginnings in the Gregorian calendar. In *Understanding Cultural Differences*, Hall & Hall demonstrate how German, French and American business people experience and act upon their perceptions of time differently [9]. To a computer, none of this matters. Time is totally predictable, sequential, and certainly laden with emotion. That linearity is not completely absent from the education system, on the contrary. Bells mark the inevitable passing of time, while clocks on the wall (or other devices) tick away weekly timetables and predetermined term dates. But to computers, a school bell does not mark dread or relief, whereas it can indeed signify that to people.

Teachers in the study preceding the observations presented here, commented how much they are meant to do in so little time; and that indeed, the job never seems done. The pressures evidence the power articulation of time and its authority over behavioural choices [10]. New tools in any form are welcome; but if trialled and tested tools work, what is the reasons for replacing it with a new tool which is more expensive, requires maintenance, appears less reliable, and demands time to learn how to use it? More pressingly, the results showed that decisions were not always made on the basis of what teachers believed to be the best pedagogical choice; their motivations related to the context of performance and accountability. This has been noted before for English teachers, in comparison to for example French or German colleagues [11]. This is not irrational behaviour in that there is a clear logic, but it is not the logic with which the software was developed and therefore the way it performs in the given context.

Though the original study was more extensive than is discussed in the scope of this paper, the reason to focus on time in this instance is because it so pertinently shows how different the meaning-making is between human and computer. Despite having a shared concept, the meaning and interpretation related to this concept are radically opposing. It is almost as if they propose alternate realities. In the computing reality, time is organised, measured, never-changing. It is certain, and mathematical. That is not how the human brain processes time. (Indeed, the ability to 'slow down time' is a neural mechanism for survival.) It is odd for a tool to be profoundly misaligned with the context of use. But as the perception of the technology as a tool is prevalent, this puts sole agency with the teacher to learn how to use it correctly. Measures such as adequate training have been found crucial to meaningful use of technology and its integration [12]. Again, this takes time, which was a key obstacle in the first place. Not that time is the sole factor to consider in technology acceptance or integration [13]; what matters is that the teacher is required to switch mindsets and speak a different language on the spot, because the computer will not and probably cannot. Teaching mathematical and computational thinking, in various forms or contexts, are one measure of improving that human-technology communication. But this has limits related to the nature of thinking itself [14], and it again places the onus on the person to work the tool correctly. Technological determinism clearly shows its shortcomings again, in favour of more socially constructivist theory, highlighted by Cuban in *Oversold and Underused*. What he perhaps didn't consider, is that the importance of the human context on use doesn't therefore mean that changing the context of human behaviour and thinking in order to incorporate technology is an answer to educational improvement; neither is not using technology altogether as it ignores a profoundly important element of society today. The conflict lies in the interaction between two different entities, so a solution may be found in reimagining that relationship. The following section considers how changes in the technology can relieve some of the pressure on the teacher; from existing techniques in the first part, followed by an alternative view which considers the technology as something other than a tool.

3.0 The Conundrum in Coding

Successful integration of technology relies on good human-computer interaction, and meaningful educational settings on the optimisation of their environments – from teacher to technology. No greater adoption of technology will come through forceful streamlining. An end user can at all times decide not to use a technology (indeed even in a mandatory implementations), or use it differently than intended. Human thinking does not always follow logical patterns; and the classroom context is not cut with the clarity of a diamond. Even when (or, because) the context is highly dynamic, emotional, and to an extent unpredictable, the teacher needs technology to be reliable, predictable, and structured. That is certainly the intention in coding, so software development faces the challenge to build programmes which are responsive to the human context. There are firstly existing techniques which can prevent errors and build the machine to be more dynamic; but Licklider's ideas offer another, more promising starting point for the development of technology in education.

3.1 Accommodating and Predicting the Messiness

The engagement of the end user with a technology can be more alike the undesireable features of software: bugs, circular references, all too complex algorithms, unnecessary comments, convoluted code,… There are existing programming techniques, as well as steps in the development process, which aim to accommodate and predict the uncertainty. This is by no means an exhaustive list; but the principles of software improvement addressed here bear a specific relevance to the following section, which proposes an alternative place for technology in education.

A thorough requirements analysis is a good start. This can move to systems analysts, leading into a functional specification or pilot software which is brought back to user focus groups. Inevitably, the end user will raise unexpected needs which must be abstracted to new parameters, procedures and objects. Human confusions get boiled down to the essence of a delineated set of system changes. 'Confronting the messiness of human life, we tried to simplify it.' [15]. This is necessary for the programme; it does not work if it is jumbled like the human mind. 'In the painstaking working out of the specification, line by code line, the programmer confronts all the hidden workings of human thinking.' [16]. The programmer is not often customer-facing. They remain a somewhat invisible force delivering the software, but they indeed hold great power in the manifestation of the technology, the teacher-technology relationship, and the educational environment. It is the prerogative of the end user, for example, to demand not only something that will work, but that will work in their context. But it is a very hard task indeed to create a working software, which demands clear declarations and process, on the basis of conflicting and confusing information coming from analysts, users, product managers, ... It is not always the case that those needs are communicated clearly, without inherent conflict, or without compromise to feasibility and user-friendliness.

Testing in all its forms is key; but especially user testing in the actual context of use. Surprisingly, this is often omitted. Nothing can replicate a classroom setting like an actual classroom. Crucial to this is that it will not exclusively test expected behaviour (more likely, the opposite). Most bugs will be found like that, but also lessons can be learned from how the user is trying to communicate with the programme. For this reason, human observation of the technology in use is equally valuable. Heatmaps, for example, are still a streamlined, organised version of a reality which was a lot more random and messy. It is a technology's reflection of reality, not the human interpretation which it still needs.

At the level of programming itself, there are other techniques currently in use. Fuzzy logic was developed to accommodate imprecise information and approximations. It is still defined and specified, but it allows for rule uncertainties to a greater degree; not unlike human thinking. Exceptions will always occur; which gives rise to defensive programming as a reasonable precaution, to protect the software from crashing or in some known cases, self-destructing. Where possible, meaningful error messages help the end user understand what is happening, but it is quite impossible to foresee every possible input. Although defensive programming is somewhat controversial in that it may ignore errors and cover bugs ; it is still preferable in this situation to offensive programming, which will make any erroneous procedure input very obvious, even if that means the system crashes. A system which crashes in a live classroom situation is quite simply, a nightmare. It is embarrassing for the teacher, and they will lose time restoring the learning process – key to the context of use, as discussed above. The teacher will lose confidence in the tool, and discontinued use is entirely possible. Recognition of an exception through a friendly 'Oops!' error message, constraining the impact of the failure to a section of the programme, is the better option. Even better, error handling can be dealt with through machine learning. In a nutshell, the software can come to recognise trends and patterns in reoccurring issues directed by user input. Though human input can be messy, it is not often totally random. There is a pattern which defines expectations. This may not match the logic of the machine, but machine learning postulates a self-governing process that remaps based on the input. That capacity to 'understand' and 'organise' new information is what allows flexibility in the educational setting. It could for example, come to understand seemingly random input as a particular teacher's way of doing things. Once the technology understands what is expected, it can be more responsive and helpful. It is not the same as automation; which follows a pre-defined process irrespective of adjustments based on varying user input. Some automation can be helpful, but it is unlikely to respond to the needs of every teacher in every classroom; and for that reason, can become more annoying than helpful. Machine learning and self-adaptive systems in contrast are one of the many major development efforts in artificial intelligence, which is not unrelated to the views outlined in the following section. But the ideas of symbiosis are far richer and ultimately more advantageous for education and society than artificial intelligence.

3.2 Embracing Symbiosis

J.C.R. Licklider described his expectation and hope for a very close coupling between human and machine; a close union of two dissimilar organisms. The dissimilarity is what makes it possible. Computers can do things which humans can't, for example in their information storage and retrieval, the speed of analysis and calculation, and indeed, the logic of computational thinking. But computational thinking could not, for example, 'solve something like a moral problem or a question of ethics' [17]. A teacher in a classroom is able to respond intuitively to the students, to adapt emotionally to their needs, and give feedback with empathy and pastoral care. Rather than conflict with each other, they can be seen as complementary. Hence the symbiotic relationship. It is an alternative to trying to accommodate and predict the messiness, because 'many problems that can be thought through in advance are very difficult to think through in advance' [18]. Symbiosis would not be necessary if a computer could truly think and act like a human, or a human like a computer. Licklider does not appear to deny the possibility of a 'distant future of cerebration to machines alone' [19], but that is not what excites him. What Licklider envisioned is for human and machine to become a partnership which is interdependent. The human sets goals and formulates hypotheses, asks the questions which the machine answers. It performs routinizable, clerical operations that prepare the way for human decision-making and evaluation. It is not uncommon to hear teachers feel overworked, stressed, and burdened by the menial duties which accompany their profession of educating living minds and bodies. Why could computers not facilitate some of this in a manner which is perhaps more active and assistive? With ever growing class sizes, increasing differentiation in learner styles, levels and needs, it could be a wonderful help. Every day, teachers reflect on the varying levels of progression and wellbeing of their students. For this, they may actively need to check a student's attendance records, combined with their grade outcomes and whichever other information is available on the student's wellbeing. This simple act will take time. It is likely to combine different software systems, perhaps each with their own logic, and even then, it is still up to the teacher to perform an active analysis. The conclusion and decision-making involves a sensitivity and care which is unique to the teacher, but the data gathering, combination and presentation could be done much more efficiently by the computer. Similarly, the *MIT Technology Review* describes a software system developed to flag up fraudulent financial transactions automatically, but moreover, it allows for people to exercise their instinct and insights based on creative, connected data analysis and presentation, and to actually have the time to reflect and make decisions [20]. In this article, the director of research strategy for IBM describes the approach, which is based on Licklider's ideas, as the most important change in human-computer interaction since the graphical user interface was developed. This mode of thinking follows cybernetics theory set by Norbert Wiener just over a decade earlier [21], who was also key in convening the group of thinkers who would lead the way to the internet and digital computing. Licklider was part of these early seminars at MIT [22].

Licklider did consider a number of hindrances which meant man-computer symbiosis in his day was not yet realised. The first was the speed mismatch (a computer thinks too fast for real-time cooperative thinking with a human), and the very real cost of computers for widespread use. But, a network 'connected to one another by wide-band communication lines and to individual users by leased-wire services' [23] would balance these things, Licklider felt. Indeed, the explosive spread of home computer technology and mobile, even wearable, internet-enabled devices have overcome the barrier which Licklider experienced in 1960. So did the second hindrance he identified: memory hardware requirements. This is where Moore's Law comes into play: the necessity for 'billions of bits' [24] which Licklider describes have today resulted in physically more compact computing devices with previously unimagined memory capacity; and web connectivity allows that to be seemingly infinite. A third hindrance relates to memory organisation; for a good partnership between human and machine, search procedures had to be easier and faster than serial search common in 1960. Today's search engines have provided much more sophisticated processes and pattern recognition; although unfortunately, almost always tainted by commercial drivers too, and with many concerning implications for privacy. So although information is now more easily retrievable without advanced technical knowledge, it had also become enframed by corporate bubbles. Commercial forces which limit the horizon of knowledge, as search engines do, are certainly undesireable. But if a computer can carry out semi-automated or active processes in the storage, retrieval and analysis of student data, to the aid of the teacher and the benefit of the learner, data protection and confidentiality must remain a priority in the development of technology for education.

The fourth issue Licklider identified related to language. A good partnership means both parties understand each other. They speak the same language. All too often, I have seen teachers struggle to communicate to the machine what they wanted to do, and vice versa. If a person does not understand what the computer is asking, then use of the technology comes to a grinding halt. For the software, exceptions occur because of unintelligible human input. For the teacher, the software appears to be malfunctioning. They may lose confidence in their own abilities (while it is not their fault) and more importantly, they lose time in trying to make sense of it all. Licklider correctly pointed out that the 'basic dissimilarity between human languages and computer languages may be the most serious obstacle to true symbiosis' [25]. In his view, computers specify courses (predetermined instructions and rules), while human beings specify goals (outcomes without a precisely formulated itinerary). The error messages which occur on the screen today are often related to faulty courses; and perhaps not the inability to perform the outcome altogether. It would be far more helpful if a technology understood what a teacher was trying to do, rather than remain stuck on the erroneous action. Though much progress has been made through the development of user-friendly interfaces, this difference between courses and goals still holds much truth. A simple action on a computer would be to save a file as a PDF in a local folder and then email it to a colleague. To do so, I have to know where to click (in fact, over twenty-five clicks, excluding typing) and moreover, this has to be done in a

particular sequence – true to computer language. One click out of order and the communication breaks down; the commands will make no sense at all to the software, and the human equally does not understand why it is not working. Advances with speech technology such as Siri or Alexa are indicative of a different mindset - perhaps more illustrative of a symbiotic relationship of human and technology in the home environment. 'Alexa, switch on the light' is a goal; whichever course the computer takes for this, is its own domain. Machine learning and semi-automation could make the technology 'know' a teacher's preferences for classroom arrangements as soon as they walk in. Licklider did have an interest in automatic speech production and recognition. Interestingly, he noted quite conservative attitudes towards this amongst his colleagues. But, 'one can hardly take a military commander or a corporation president away from his work to teach him to type' [26]. It is not how you would interact in a partnership. Similarly, does it make sense to train a teacher to learn how to click through a programme in order to make it work? That is the nature of a tool – you have to learn how to use it properly, and this is time-consuming (which is problematic in the educational setting). Licklider continues to say that 'it would be dangerous to count on having more than ten minutes in which to make a critical decision' for a military context. In a classroom, having ten minutes spare to work out how to use something is quite a luxury too. Many teachers will have experienced a painfully slow log-in on a classroom computer, which is running background checks, central server processes or installing updates – while the students wait. Of course, there are other considerations such as the noise levels in a classroom, and also voice recognition (lest a student takes control over the teacher's computer) but these are not insurmountable objectives for the next few years of educational software improvement.

A final element in Licklider's consideration was the input and output equipment. The basic hardware in the form of displays and controls which would allow effective, real-time communication. The keyboard, still in use today, appeared to him quite unsophisticated. A computer should be able to read human writing, for example. He foresaw desk surface displays – which are indeed operational today although not so commonly adopted in schools; but tablet devices can be considered the portable version of this idea. Also, wall displays – which have perhaps materialised in electronic whiteboards not yet imagined at the time of his writing. It is still the software processes which will enable a compatible meeting of the human mind with the logic of the machine, but their physical manifestation in the classroom enable that compatibility to its full potential. However, in many ways, the invisibility of the hardware in a classroom is not undesireable. It allows the humanity of teaching and learning to take the forefront.

Licklider felt it would only take five years to achieve significant speech recognition software; and that the development of artificial intelligence would take until 1980 before machines alone could do much problem solving of military significance. It has all taken longer than that. However, today's realisations in commercially available and widespread technology shows that many of the barriers which he envisioned no longer constitute a great hindrance. In 1960, there was

nothing ‘approaching the flexibility and convenience of the pencil and doodle pad or the chalk and blackboard used by men in technical discussion’ [27]. These were tools of the time, still in use today – and it seems of little use to replace one tool with another. (Especially if the new tool is more expensive, requires maintenance, requires training to use it, …) But the potential which Licklider saw in technology, for the benefit of human intellect, could not be found in chalk or pencils.

4.0 Conclusion

All code is written to be logical and structured, but human thinking and real-life classrooms are not always so pre-determined. The limits of technological determinism are often found when technology meets the human context in actual use. The assurance of internal reliability and predictability, and the clarity of its code, appear to be muddled. The conflict is apparent when a teacher believes a functional software acts unpredictable; while nothing in the machine can happen unexpectedly unless it is broken. It is almost as if they speak a different language. Larry Cuban was key in pointing out the significance of social constructivism in the use of technology in classrooms. Factors in the context of use appeared more influential than the promise of the technological potential. Time in particular has been found to have a significant impact. Crucially, it illustrates the competing realities which a person and a technology hold. It is laden with significance in the classroom context, against a bigger picture of exams, inspections, lesson plans, pedagogy, learning needs, classroom discipline, and so on. There is no emotional, interpretive element to time in the software. The programme runs in a disinterested, sequential manner which gives it that serenity that does not match its context of use. But as it is a tool, it is up to teacher to learn how to use it effectively and imaginatively. The teacher has to switch between mindsets and languages on the spot, in order to use the technology.

To relieve some of the unisided pressure in the use of educational software, development processes can and do incorporate a number of techniques to accommodate or predict the messiness, to ensure continued functionality of the programme. It appears an almost never-ending struggle; and perhaps it will prove to be an impossible one. Moreover, the idea that this will be the most fruitful way to integrate technology in education (or society in general) is questionable. True improvement for the benefit of the education system lies perhaps in reconceptualising the place of technology in relation to the teacher altogether. This alternative can be found in the ideas proposed by internet pioneer J.C.R. Licklider. His *Man-Computer Symbiosis* suggested a partnership where two distinct but complementing actors unite. Rather than a tool, technology becomes part of a team in which the human takes the lead in decision-making and steering capacity. But the role of technology becomes more active and assistive, freeing up the teacher’s time to focus on what only a human can do – things such as pastoral care, emotional analysis, or thoughtful pedagogy. Rather than spending time on learning how to use a particular tool for the lively environment of a classroom, the technology is actually there to help and understands how to do that. Like any good

partnership, actively complementing strengths becomes possible through cooperation, easy interaction and mutual understanding. Software can make this compatibility between the human mind and the machine happen; although it goes hand in hand with appropriate hardware. Reimagining the role of technology in this way, and developing software accordingly, overcomes the long-standing conflict between the messiness of human life and the desired clarity of a software. Moreover, it can inspire a more imaginative use of technology in education.

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Towards a Framework for Process Quality Management of Distance Mode Research Supervision

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Abstract

Embarking on any programme of study in any format requires motivation and sustained dedication. Distance Education (DE) enables students who may be restricted from attending face-to-face classes by their professional and personal conditions including distance from the place of study, work, family, or health. DE is pursued at the student's own time, own place, own pace (although pace/timing can frequently be determined by the university). The majority of Distance Mode Students (DMS) study part-time at undergraduate, Masters and increasingly more recently at doctoral level. Studying part-time and at a distance from the university campus presents additional challenges for the learner. DMS studying for a Doctorate can be mature students, often with young families and work commitments. They generally have considerable work or learner experience which tends to have a positive effect on their study efforts. However, many obstacles arising from conflicting demands on their time, restricted access to facilities (such as the campus library and resources), lack of interaction with other students and with their supervisor may result in isolation, loss of confidence and diminished dedication. The motivation for writing this paper emanates from the experiences gained by the authors who,between them, have supervised 45 PhD students in the fields of Software Engineering, Information Systems 15 of which were Distance Mode and based in Egypt, Finland, Greece, Saudi Arabia, UAE, USA), examined over 35 PhDs and over 40 MPhil/PhD Transfers. This paper draws on their collective experiences gained in general and in supervising Distance Mode PhDs in particular. The unprecedented development and use of electronic/online technologieshas brought immense changes in DE and the authors propose a quality management framework for the supervision process from both the student's and the supervisor's viewpoint.

Keywords: Distance Education, ICTs, Process Quality Management, Distant Supervision, Doctoral Studies

1.0 Introduction

1.1Distance Education Over Time

There is evidence that distance mode learning and teaching has been taking place from ancient times, through to early Christianity. Guri-Rosenbilt reports "correspondence between Plato and Cicero and their students, and the famous letters sent by Apostle Paul to the early Christian communities" [1]. Kingsley [2] provides a historical summary of distance education from tutorial classes for social sciences to today's e-learning programmes at degree and Masters level.

The main characteristic of Distance Education (DE) is the opportunity it offers to overcome barriers of space, distance, time, disability, social class, conflicting obligations (work andpersonal life), and prior education [3,4,5]. In the UK the Open University (OU) was founded in the 1960s on the belief that communications technology could bring high quality degree-level learning to people who had not had the opportunity to attend classes on campus. The OU is a public, mainly distance learning and research,university, and one of the biggest universities in the UK for HigherEducation "*being open to people, places, methods and ideas"*[6].

1.2 Terminology Explosion

The growth of Distance Education (DE) has been aided by the growth, availability and affordability of Information and Communication Technologies (ICTs). This growth has also resulted in new terms which however are often used interchangeablyand as synonyms. Guri-Rosenblit[3] points out the differences between Distance Education and e-Learning. Bozkurt et al.[7] examined 633 scholarly articles (covering 5 years from 2009 to 2013). They reported that at least 12 terms are used by scholars to describe DE, including Distance Education, Online Learning, e-Learning, Blended Learning, Open and Distance Learning, and Open Education.

In this paper the generic term Distance Education (DE) will be used with primary focus on supervision for PhD programmes by DE."*The term Open and Distance Learning (ODL) has appeared in increasing frequency, especially in the last two years in congruence with a decrease in the use of the term DE in the same time span. This change from DE to ODL as a generic term might be a consequence of the openness movement in general and the use of OER, MOOCs, Web 2.0 and open spirit on networked Web environments in particular"* [7].OER stands for Open Educational Resources and MOOCS for Massive Open Online Courses.

2. Stakeholders

2.1 Conflicts

The primary stakeholder in the research journey is the student. The expectation of students embarking on distance mode studies includes career progression, continuous professional development either through own choice or through

pressure from employers, and interestingin learning. Cost and flexibility in terms of space/place, time and pace are often motivating factors [4, 5, 6, 7, 8].

Evans [8] observes "*distance learners are likely to be a much more heterogeneous group than would be found in a conventional classroom; their social, economic, spiritual, political, experiential and personal dimensions add many interwoven layers to the distancing of the teacher from the student".*

It is important to ensure that the needs of the Distance Mode students are identified and addressed. The majority of these students study part time, are aged between 25 and 60 facing multiple pressures and obstacles. A high degree of motivation and commitment is required. The supervisor(s) need to be aware, capable and willing to provide timely support. There is evidence that using ICTs facilitates interaction and communication.

As can be seen in the Rich Picture [9] (Figure 1), all stakeholders have certain misgivings, worries, and anxieties. Such issues are likely to have detrimental impact on the progression of the student and can even result in deferrals, withdrawal or failure. The student (researcher) is not working in a vacuum. The research process is a subsystem within a Graduate School structure, a department, a university, a particular country, within a political, socio-cultural, economic, and within legal and ethical environment. The whole process is moulded and facilitated or impeded by these factors and changes that occur during a period of typically 3years for full time or 7-8 years for part-time, which is the expected duration for doctoral studies in the UK. Therefore it is important to identify these factors and the risks they may pose to the stakeholders and primarily to the student. These can be:

- **P**olitical: stability and likelihood of institutional change (e.g. restructuring and academic regulations);
- **E**conomic : resources (laboratories, library, human resources), attitudes to debt, sponsorship, e.g. bursaries and fee waivers to support scholarship students;
- **S**ocio-cultural: social taboos, stereotypes, attitudes towards life/work balance, knowledge sharing, plagiarism, cultural valuessuch as the Hofstede Cultural Dimensions [10, 11], *Power Distance* i.e. attitudes towards power, *Individualism vs. Collectivism* (i.e. attitudes towards working in groups), *Individualism vs. Collectivism* (i.e. in-group and out-group mentality),*Masculinity v Femininity* (i.e. gender tensions and competitive behaviour);
- **T**echnical:digital literacy**,** emergence of new technologies (internet, mobile technologies, social media and the way in which they enable technology transfer and knowledge sharing), availability and affordability;

- **L**egal: the university's obligation to provide the necessary resources, the student to meet their financial obligations, respect intellectual property considerations and complete within the required period of registration;
- **E**thical: the supervisor's responsibility to guide, advise, support, ensure academic integrity in research activities.

All research students are faced with challenges in their journey from doctoral applicant, to doctoral candidate and beyond. This paper concentrates on Distance Mode Students (DMS) i.e. students based away from the campus and often in a different country to that of the University. Challenges faced by DMS students are identified and strategies for dealing with issues are proposed.

A DMS is likely to feel more anxiety, isolation, loneliness, and, insecurity than campus-based students. Figure 1 and Table 1 summarise the issues.

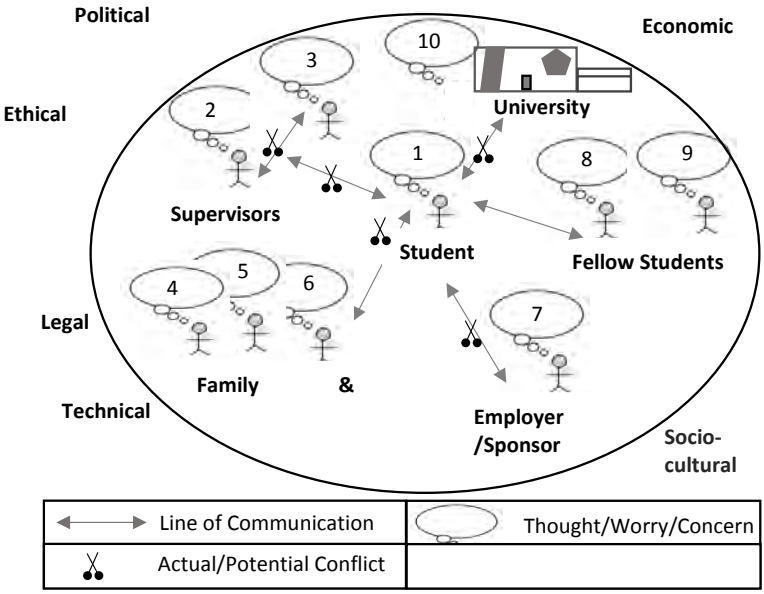

Figure 1: Demands, pressures, worries, conflicts faced by Stakeholders

Table 1: Worries, Anxieties, Aspirations, Risks and Impact

	Worries/Anxieties/Aspirations	**Risks/ Impact/Feelings**
Student (1)	Right research track? Adequate progress? Timely progress? Cannot devote time to family or friends Cannot devote time to other activities (social, cultural, etc.) Finances Obligations to sponsor Cultural/religious differences with supervisor	Insecurity Alienation Isolation Loneliness Acrimony Slow progress Deferral Withdrawal Failure
Director of Studies (Principal Supervisor) (2)	Lack of communication Student not feeling/acting as a member of a group (Community of Practice) Student too attached, too demanding Cultural differences Incompatibility between Teaching and Learning styles incompatibility	Slow progress Disappointment Difficulty of adaptation
Additional Supervisors (3)	Different approach to other members of supervision team	Confusion
Family and Friends (4) (5)	Student not providing support/ignoring family Student ignoring friends	Misunderstandings Bad atmosphere PhD Progression affected negatively
Employer (for working students) (6)	Student not concentrating on work Is student providing benefit to company (if sponsoring studies)?	Relations at work affected negatively
Sponsor(7)	Will the student provide benefit?	Embarrassment Lack of progress at work PhD progress affected negatively
Fellow Students (8, 9)	Conflict of interest (overlapping research topic?)	Competition
The University (10)	Number of completions Reputation (via PRES data) Research focus /funding Quality Assurance	Pressure

Figure 1 identified the stakeholders and the issues whilst Table 1 described the identified worries, anxieties, and aspiration of DMS which are shown and numbered (from 1 to 10) in the Rich Picture. Table 1 also identifies the impact on the psychological state, motivation and progression of the student.

All students need to negotiate conflicting demands on their time as shown in the Rich Picture. DMS are likely to face additional obstacles and conflicts which are likely to impede their progress.

By far the most important relationship in the PhD journey is that of the student and their supervisor. The doctoral supervisory relationship evolves over time from guiding, to encouragement of independence, balancing hands on/hands off approaches, challenging, inspiring, supporting then letting go. Table 1 shows the worries, anxieties, aspirations, risks and impact of situations that unsettle the student especially when they are working from a distance from the university, their supervisor, and fellow research students.

2.2 Setting Boundaries

Each student is different and so is each supervisor. Thus the relationship must be managed and boundaries must be agreed understood and managed [11].

Benmore [11] studied the evolution of the relationship between the doctoral student and their supervisor. This relationship matures from the early stages when the student is more dependent on the supervisor for advice and guidance through encouragement, balancing hands off with hands on monitoring and developing into a relationship of discussion of equals. Benmore [11] summarises the findings in Table 2.

Table 2: Boundary Management in Doctoral Supervision[12]

Time boundary	**Cognition boundary**	**Possible supervisory roles (through secondary boundaries: relational, emotional, physical)**
Early days	Exploring, discovering, focusing	Guide or direct
		Encourage and/or expect development of independence
Data collection	Doing and finding out	Balance monitoring progress with responding to updates – hands off or hands on
Progression to PhD	Analysis and sense-making	Challenge and/or inspire
		Intervene and/or influence
		Provide feedback
Completion	Critically thinking about originality and contribution	Be a sounding board
		Shape the outcome
		Let go
		Edit

2.3 Synergies

The same stakeholders identified in section 2.1 and discussed in section 2.2 couldalso support the student. Supervisors, the university, family, friends, employers etc. can, in their own different ways and at different junctures in the PhD journey of the student, alleviate worries, encourage, inspire, and support in practical ways.
As shown in Table 2 support can come in many forms: acting as a sounding board, guiding, inspiring and so on. Family and friends can also play a helpful role. Employers can relax pressure especially at crucial points.

Paulo Coelho, in The Alchemist [12] suggests that "*And, when you want something, the entire universe conspires in helping you to achieve it."* Such an aspiration may motivate the student but wishful hope, however good for the soul, cannot replace the need for a systematic identification and discussion of and monitoring of the issues. The onus should not only be put on the student as such an approach is counterproductive. The University through its support mechanisms and the supervisors need to be aware and pro-actively monitor the progress of the student by providing disciplinary as well as pastoral support.

2.4 ICTs and DE

Information and Communication Technologies (ICTs) are enabling instructors/ supervisors to use and apply a diverse set of pedagogical approaches for supporting learners in their learning process. Academics are invited to create more engaging, interactive and flexible pedagogical approaches with learning materials, in a wide range of digital and multimedia formats, which are available to students for use in the classroom or in a distant mode, through computers or mobile devices. To realise the full potential of the use of ICTs in teaching and learning, the educational institutions need to acknowledge that a change is needed in terms of investing in the required infrastructure, strategy and staff development. This is crucial in the context of DMS, as the main focus of supervisor-DMS interaction needs to be supported by ICT platforms.

3. Culture and DE

Open and distance learning can be seen as a process sensitive to social, cultural, and contextual factors[13]**.** In traditional learning environments with learners from different cultures it is difficult for theinstructor to accommodate every student's own culture. As a result a collision of different cultures may occur. In order to avoid this, the students are expected *"to step out of their own culture and temporarily enter into the culture of the instructor*" [14p. 1]. Within this process, difficulties may arise if the pedagogical values of the instructor are not compatible with assumptions of the students regarding how teaching should be done.

The question seems to be whether conflicts deriving from cultural differences also occur in the distance learning environment? If this is the case, how do instructors and students handle these situations?

Zawacki-Richter and Anderson [15]argue that one of the major challenges educators face today in distance education that go beyond national boundaries, is to determine how to design and deliver online courses suitable and relevant for the socio-cultural context of the learners. They call for studies with focus on cross-cultural concerns of open and distance learning and globalisation of education.

Rogers et al.[16] put emphasis on the fact that learning content being developed and spread via on-line Learning Management Systems (LMS) to other countries, raises the question of the influence of culture on learning in open and distance mode course designs, as many students experience difficulties of adaption and conflicts arise due to the incompatibility of teaching and learning styles. Jayatilleke and Gunawardena [17] analysed the views of cross-cultural faculty members and concluded that "*even though ICT has the potential to cross national and geographical boundaries and converge participants in a virtual environment permitting greater flexibility in offering transnational programs, it is still crucial to examine the cultural frameworks and expectations students and teachers bring with them in order to build inclusive online learning environments*". In their study, a majority of participants indicated that the distribution of power in their traditional culture will influence how they communicate online, even though some participants felt that online communication will breakdown power barriers that exist in society. Similarly Kebritchi [18] asserts that instructors play different roles in different cultural contexts. In a hierarchical society with high power distance values, the teacher is perceived as a 'guru' who transmits absolute knowledge to the learner, whilst in egalitarian societies with low power distance values, the teacher and the student are perceived as equals. As a result it may be difficult for students from high power distance societies to understand that the role of the instructor in an online environment is much more student-centred compared to traditional teacher-centred classrooms and this also applies to DMS. Another key issue in education is social interaction, which includes social relationships between instructors and students and among students.

Students tend to associate effective social interaction with satisfaction, enjoyment and effectiveness of online learning, as well as the likelihood of taking another online course. Effective social interaction is also perceived a prerequisite of quality assurance in distance education.

Another significant issue raised by culture is the concept of knowledge sharing and collaboration in participative activities [19]. In some cultures individuals tend to hoard knowledge for various reasons and particularly if there is evidence of rewards to '*indispensable*' stakeholders. To encourage knowledge sharing educators should focus on developing a positive atmosphere through recognition of contributions and improvement of relationships [20].In order to overcome cultural discrepancies Damary et al.[21] propose that instructors need to develop strategies to motivate, support and counsel students in order to facilitate healthy interaction patterns and a positive on-line learning experience. This implies that instructors need to acquire new skills and competences fundamental for multicultural online teaching and learning. Section 4 presents the influence of these factors on supervision quality.

4.0 A PhD Supervision Quality Management Framework

4.1 A Generic PhD Process

Table 3 describes the various research activities and the actions and decisions taken.

Table 3: Phases, Steps, Decisions, Actions

Phases	Steps	Research Activities	Decisions (and Actions)
0	0	Proposal	D1 (Rejection, Rework, Progress)
1	1	Literature Review, Context	D2 (Rejection, Rework, Enrolment, Progress)
	2	Research Topic, Research Question	
2	3	Research Method	D3 (Rejection Rework, Registration, Progress)
	4	Research Plan	
	5	Registration	
3	6	Data Collection or Software Analysis	D4 (Rejection Rework, Transfer Progress)
	7	Data Analysis or Software Design	
	8	Transfer	
4	9	Findings or Implementation	Feedback sessions and rework as required
	10	Evaluation and interpretation or Testing, Validation	
	11	Conclusions	
	12	Write Up	
5	13	Pre-Viva Preparation	D5 (Preparation, Rejection, Rework Award of MPhil Award of PhD
	14	Mock Viva	
	15	Viva	

4.2 Phases, Steps and Decisions and Actions

Figure 2 depicts a typical PhD process divided into Phases, Stages and Steps. At every Phase there is a formal Decision Step (Dn) ensuring that quality requirements and standards are met before proceeding to the next phase or step.As shown in Figure 2 the research journey follows 6 Phases (0-5). Sufficient reviews, rework and resubmission are provided.

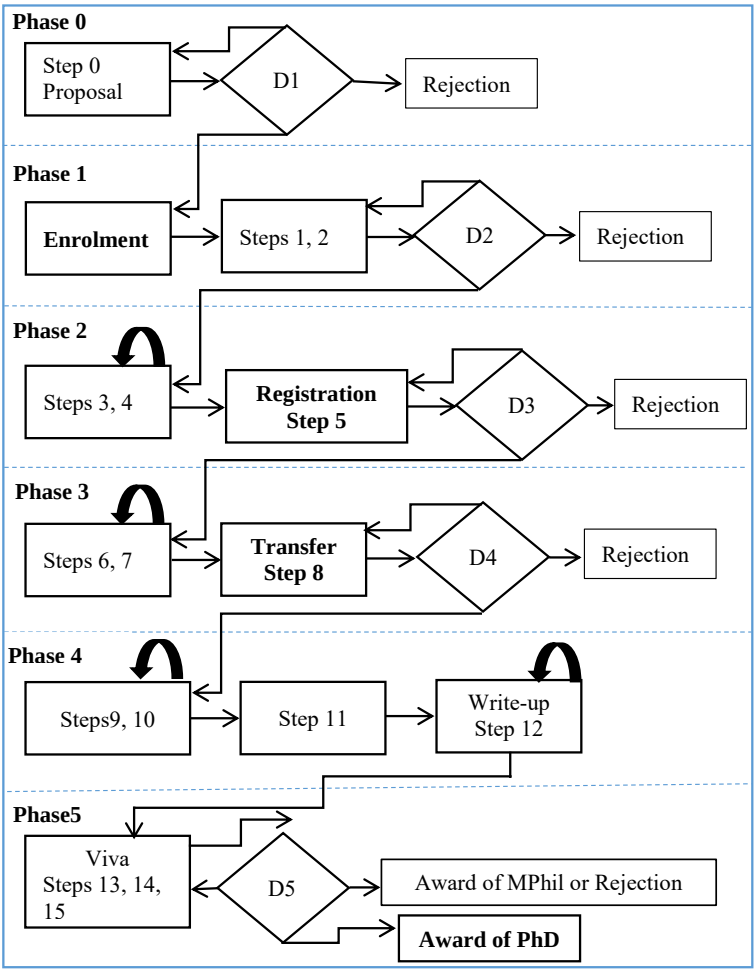

Figure 2: Generic PhD Process Model

In certain cases, such as lack of progress, external circumstances, or sub-standard work, the decision is Rejection.

The supervisors are the gatekeepers of Quality throughout the research journey and adhere to ethical standards both according to the University's Code of Ethics and Universal Ethical and Legal obligations.

Each Phase consists of a number of Steps which culminate to a Decision point. Each decision point results in three possible Actions namely proceed to next Phase, Reject, or Rework.

Table 2 provides an outline of the Phases and Steps as well as the respective decision and Action points. Normally decision point D1does not involve external experts. Decision point D2 is also carried out internally unless the supervisor would like the opinion of an external expert (e.g. a critical reader). Decision points D3, D4, and D5 are required to involve an independent reviewer (with specific expertise in the subject) from either an internal academic or an academic from another university. Usually an administrator from the research office of the institution must be present to document the process and the decisions.The viva always involves at least one external examiner who is an academic with suitable expertise and experience of both supervision and examining.

Phase 0: Preliminary Selection andDecision Point 1 (D1)

The intended supervisor(s) consider whether the candidate satisfies the entry criteria (prior qualifications, learning and experience), and the proposal is judged for quality and originality of the main research question. It is important to ensure that the proposed research fits into the strategy of the institution/department and that there exist resources (such as adequate laboratories) and academics with knowledge and interest in the subject. This Phase is entirely carried out by academics and administrators within the University unless the opinion of an external expert is necessary in which case the University and the Supervisor organise the external experts' participation in the evaluation of the proposal.

Character references and academic references as well as an interview explore the commitment of the candidate and their understanding of and attitude to this type of work.

As shown in Figure 2 there is an opportunity to ask for reworking (time limited), refinement or re-alignment of the proposal. At this point the student may have only a broad topic in mind. If the reworked proposal is not satisfactory, the action will be applicant rejection. If accepted, the applicant continues to Phase1.

Phase 1: Towards Registration and Decision Point 2 (D2)

Formal registration takes place in Phase 1. Normally the supervisory team considers whether the student has read around the subjectproviding the context and has narrowed the topic encapsulatingit in a Research Question. **D2**may resultin 3 actions namely rejection, rework (time limited), proceed to next Phase.

4.3 Quality Gatekeeping

The university through its research committee and ethics committee ensure that the researchers adhere to ethical standards both according to the University's Code of Ethics and Universal Ethical and Legal obligations.

All universities operate a Code of Research Ethics. For example the European University Institute's Code of Ethics [22] in academic research emphasises the need for academic freedom as well as integrity, accountability and responsibility.Academic freedom is the freedom to *"pursue knowledge and research without unreasonable interference or restriction from law, institutional regulations or public pressure. Its basic elements include the freedom of scholars to inquire into any subject that evokes intellectual concern, to present findings, to publish data and conclusions without control or censorship and to teach in the manner they consider professionally appropriate. At the same time, integrity, accountability and responsibility in conducting academic research form the cornerstone of any academic enterprise and violations of widely-recognised academic research standards represent serious offences to the entire academic community at the Institute and are considered injurious for its credibility and authority as an institution that promotes excellence in academic research in Europe*".

In the case of DMS local approaches to Plagiarism, Intellectual Property Rights, and Personal Freedom may vary from approaches and practices by the University. The supervisor needs to acquaint the DMS with the University's code of Ethics, and devote additional time to provide on-going support in the form of informal sessions to ensure that the relationship between them and the student is built on confidence and trust. In Figure 2 these sessions are shown by the rework loops at each decision point. At each Decision point, opportunities for discussion, as shown by the thick arrows, feedback and guidance are provided by the supervisor(s). These informal sessions are important as they increase trust, understanding and commitment by both the student and the supervisor(s).

4.4 Distance Mode Students

As discussed in the beginning of this paper, students based at campus have the opportunity to present to fellow researchers and academic staff and discuss their work in research seminars where valuable feedback is obtained. For DMS these opportunities have been rare or non-existent in previous years[2, 5, 23, 24].

With recent development of ICTs and social media connecting with a conference room to either present or attend seminars are increasingly providing opportunities for quick and frequent exchange of ideas and feedback.

Technologies including audio-visual, hypermedia, interactive, adaptive and discursive media are generally available and accessible, although in certain countries and certain situations availability and accessibility cannot be guaranteed.

With social media a DMS can now be an active member of a Community of Practice (Wenger [25] Technologies, such as video conferencing systems (e.g. Skype), are extremely important for DM students.

Most UK universities offering Distance Mode PhD studies require the student to visit the university for brief periods in order to deliver and attend workshops and seminars and discuss with his/her supervisory team. Universities may also require the student to present their Transfer Report.

The Viva is normally held at the University and therefore the student must physically attend and defend their thesis.

5. Conclusion

Despite the changes in technologies and the proliferation of novel approaches as the use of new terminology testifies (from correspondence to ODL; from blendedto electronic toonline;from synchronous to asynchronous), what remains constant is the need for the provider of DE to ensure that a clear framework of managing the quality of the process exists so that students and supervisors are aware of their roles and responsibilities. The Quality of the process is imperative for maximising the probability of a good experience for the student and a high quality of the researchoutcomes.

The most fundamental relationship in the PhD process is that between the student and their supervisor. This paper identified the main obstacles faced by PhD students and especially those studying in distance mode. It also discussed the need for boundaries management.

There are potential difficulties for supervisors engendered with the introduction and 24/7 availability of new technologies. Students may demand constant attention and support. We intend to explore this aspect in future research along with formal interviews of past and current DM PhD students as well as their supervisorsin order to validate the framework we proposed in this paper.

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Internet of Things for Education: Facilitating Personalised Education from a University's Perspective

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Abstract

Personalised education has been a developmental goal across all levels of the UK education sector for many years. In particular, the Higher Education sector has struggled the most due to a lack of personalisation, as student numbers in lecture theatres have grown significantly, occasionally exceeding three hundred. Asa consequence, educatorsare constantly challenged to gather and understand individual student needs, let alone address them. At the same time, technology has advanced in the recent years, particularly in the areas of Internet of Things (IoT) and big data. IoT technology has emerged as a great means to collect data from lecture theatres and labs, while big data technologies enable the processing of these data. Consequently, IoT offers potential solutions to some of the key issues facing the future of personalised education. In this paper, an IoT system is being proposed, which would enable the personalisation of education for large groups of students in lecture theatres and labs. The proposal is derived from a case study based on work which has taken place in a mid-sized UK university.

Keywords: IoT; Education; Systems; Personalised education; SysML

1.0 Introduction

This paper discusses the integration of IoT in Higher Education in an attempt to address the need for developing furtherpersonalised education as it becomes more popular. To do so, a case study will be used to showcase the introduction of an IoT System at Bournemouth University (BU), England.

IoT technologies have grown significantly over the past few years. According to an article released early in 2018, “The number of internet connected “things” already exceeded our population back in 2008. By 2020 this number is expected to reach 50 billion. A whopping $19 trillion is anticipated as cost-savings and profits from this investment.” [1]. The growth of interconnected ‘objects’ is permeating every aspect of modern life, including all levels of education, where there is a growing expectation to take advantage of the perceived benefits of ubiquitous connectivity between devices. It is becoming evident that by incorporating a variety of technological enhancements into teaching, educators are able to place personalised education at the centre of a student-centred teaching approach. In doing so, students can customise their learningactivities, taking into account their personal circumstances, and their own learning style. Evidence of such advancements have been noted as part of several projects that have taken place globally in recent years for smart education [2].

AtBournemouth University, as it is the case inother institutions, it has been suggested that IoT technology, and more general technological innovations in general, could address the issues of personalised education for the benefit of both educators and students. Teaching in large lecture theatres, but also performing complex administrative tasks which require the use of multiple and often disjointed IT systems, are a few of the problems that educators face. Students often note that they are adversely affected by the lack of personalised learning and feedback. They feel their individual learning needs are diluted and often lost in large student crowds, leading to low student satisfaction that reflects directly on their learning achievements. Although there is funding allocated to support the enhancementof the provision of personalised education through technology, thus addressing some of the issues stated earlier, careful planning and appropriate research are required in order to propose a viable technological education system.

As part of an attempt to conduct such research, this paper attempts to define the requirements and propose a design solution for a specific case study which focuses on the personalisation of education through technology. The SysML modelling language has been chosen both for requirements and system description purposes. SysML was chosen as a standard formalism for systems engineering and the inherent benefits of model-based design techniques such as code generation, and identification of problems early in the product design and development cycle.

Subsequently, an IoT system is then proposed displaying it using SysML Block diagrams. The diagram is then evaluated against the requirements that have been identified,

The rest of the paper is organised as follows: in section 2, a background study of IoT systems in higher-education in general is detailed. Section 3 describes the case study of personalised education and IoT. Section 4 contains a short description on the requirements modelling process. Section 5 proposes a system relating to the case study and from the data collection viewpoint, through the use of block diagrams. Section 6 offers an evaluation of the proposed solution and open issues. Finally, section 7 offers conclusions gathered from undertaking this paper, and suggestions for future research.

2.0 Background study: IoT systems in Higher-Education Institutions

IoT is a recently devised term but its use and practical application has beengrowing in many organisations. “The Internet of Things (IoT) is a growing market. Estimates show that by 2020 we could have over 50 billion smart connected devices, a.k.a. things, on the internet.” [3].

IoT systems are used in several areas in Higher Educationsuch as: attendance monitoring, personalisation through feedback, personalisation through learning analytics, physical access security, environmental conditions monitoring, and others.

2.1 Attendance monitoring

There are several cases of IoT systems which have been implemented for the education sector. Examples include the use of RFID tags to monitor student attendance, and the incorporation of attendance monitoring data into a wider university system. “As students walk into the classroom, attendance could be logged automatically using a device such as the Nymi, a wearable “smartband” that uses the wearer’s ECG pattern to authenticate identity. When the students take their seats, a beacon might push a warm-up exercise directly to their smart surfaces.” [4]. The benefits of such an approach relate directly to the extensive evidence which shows that attendance monitoring leads to higher student attainment.

2.2 Personalisation through learning analytics

A recent and innovative example of IoT technology that has been proposed for personalised education is the Muse headband. “Muse, a headband that reports brain activity to a mobile app, could help academicsmonitor student engagement and track learning styles” [5]. The device contains sensors in the headband positioned on the user’s forehead and behind their ears that tracks the activity of the brain. A lecturer can then access the application to determine students’ individual learning

styles which could lead to a more personalised curriculum being delivered to them. For example, if the headband detected that the student learns more by performing certain activities, then this could be created for the student.

Another example are the ECG sensors[6]for monitoring how well students are assimilating and comprehending what is being taught.This is certainly aninteresting development, which may leadto a more efficient classroom environment where academics have greater control of the teaching environment. For example, EEG sensors could be used during teaching to monitor the students' cognitive activities.

Personalisation through feedback acquisition is another area that IoT has shaped. Studies examiningthe use of mobile technologies to acquire real-time feedback in large lecture theatres have emerged in recent years. In these studies, a mobile app called *socrative* was employed to provide real-time feedback from large numbers of students[7, 8].

Lastly, social media technologies such as *Facebook and Twitter* can be used to collect valuable data for learning analytics as their is an inevitable fact in modern higher-education institutions[9].

Therefore, through the use of IoT technology, academics can collect data about students' performance and engagement, and then determinewhich students would benefit from additional support. This type of technology has been shown to support academics to adapt their teaching plans and methods for future classes[10].

2.3 University physical security

This is another example that showcases the potential value of IoT. In this case an example of IoT technology can be found in the useof RFID (Radio Frequency Identification) and NFC (Near Field Communication) to simplifyand improve physical access and campus security. Student physical access can be monitored whilst on campus via RFID chips embedded on student ID cards. The system would record access when students enter a room via physical devices placed around campus. An example of such technology in use has been implemented in the Sookmyung Women's University (SWU)[11]. As part of the same infrastructure at SWU, student attendance can be monitored, as students move in different buildings, using a mobile app. Unsurprisingly, there are several other universities which have invested in this type of student attendance monitoring technology.

2.4 "Green" universities

Finally, an example of existing IoT technologies in use in this context is the Smart Classroom System. This type of system works in real-time to determine if the physical environment is optimised for student learning, by taking into account parameters such as temperature, noise, CO2 and other environmental factors.

Taking this one step further, the monitoring of classroom environmental conditions through IoT could lead to a "Green campus environment" [12]. Eco-system monitoring is implemented through the use of physical devices, similar to the case study of this paper, to gather energy consumption information.

3.0 Case study: Personalised education and IoT

Bournemouth University is a typical example of a medium size higher education institution in the UK. Like many other universities, BU has been looking at ways of enhancing the learning and teaching experience of its students by further developing the personalised education they receive. One of the initiatives being pursued, relates to investing in IoT technologies to support the development of innovative learning and teaching methods used for delivering teaching in large lecture theatres and computing laboratories.

The basis for the new IoT development revolves around the idea of building an IoT system which will be deployed in large lecture theatres and computing laboratories (IoT in this case refers to the combination of physical devices such as sensors and computing systems to process information generated locally but also existing as part of other interconnected IT systems). The introduction of this technology is expected to lead to the customisation and enhancement of the students' learning experience, by allowing the optimisation of teaching materials, and their different forms of delivery. It is also expected to enable educators to focus on individual student learning needs and methods of learning. Additionally, there is a reasonable expectation of reducing both direct and staff costs by automating common tasks which are not directly related to the actual educating of students,i.e., tasks which require academic expertise, as stated in [13].

Unlike industry which generally invests heavily in new technologies, academic institutions tend to lack similar investment levels. This is mainly due to inflexible funding mechanisms and a general lack of appreciation of the business value that IoT and data analytic technologies can provide."An educational system may be one of the most important reasons why countries do not grow" [14].

Yet, these technologies offer the means to managing costs, improve the quality of the educational provision, professional development, and improvementsacross a number of areas such as:

- Student response, performance, and behaviour
- Academic response, performance, and behaviour
- Facility monitoring and maintenance
- Data from other facilities

To achieve improvements in these areas, collecting data and processing them effectively (big data analytics) has been identified as a necessity. "Using big data enables managers to decide based on evidence rather than intuition. For that

reason, it has the potential to revolutionize" [15]. Relevant data can help inform ineffective strategies and actions, whether they relate to teaching and educational efforts, or the effective management of facilities supporting education.

IoT has been characterised as a plausible solution to many of the aforementioned issuesand has been described as "dawn of a new era" [16]. Apart from providing insightful information which supports decision making, it can also become an information enabling tool through the use of low costand low-power small devices, which offer high performance.

In many ways, the drive for utilising technological innovations is fuelled by the increasing demands for academics to deliver high quality personalised education. The demands to succeed in this area are supportedby higher student expectations for more effective learning and teaching.As academics are called to meet these higher expectations it becomes inevitable to look at efficiency gains in terms of reducing the administrative burden and management duties, which detract from focusing on the core academic mission of providing excellence in teaching. Invariably, the automation of manual and clerical tasks becomes a necessity. The application of technology is seen as an invaluable improvementin working practices, enabling academics to devise better supported learning and teaching strategies, rather than simply relying on old or ineffective methods of teaching activities.

Beyond the benefits of the technology itself, and the academic drivers for innovation, there is an emerging student perspective, which views the customisation of education as the gateway to achieving higher learning goals that are based on contemporary learning styles.Key qualities such as "responsibility, self-management, independence, confidence, resilience, creativity and entrepreneurial" [17] can be realised only when students control their learning experience and participate in the development of their highly personalised learning and teaching.

4.0 Requirements modelling for Case study

4.1 High-level diagram – Data Viewpoint

The diagram in Figure 1 shows the overall requirements of the IoT system that has been proposed as part of this project. Note that the notation used was SysML Requirements diagrams which give a structural view of the requirements.

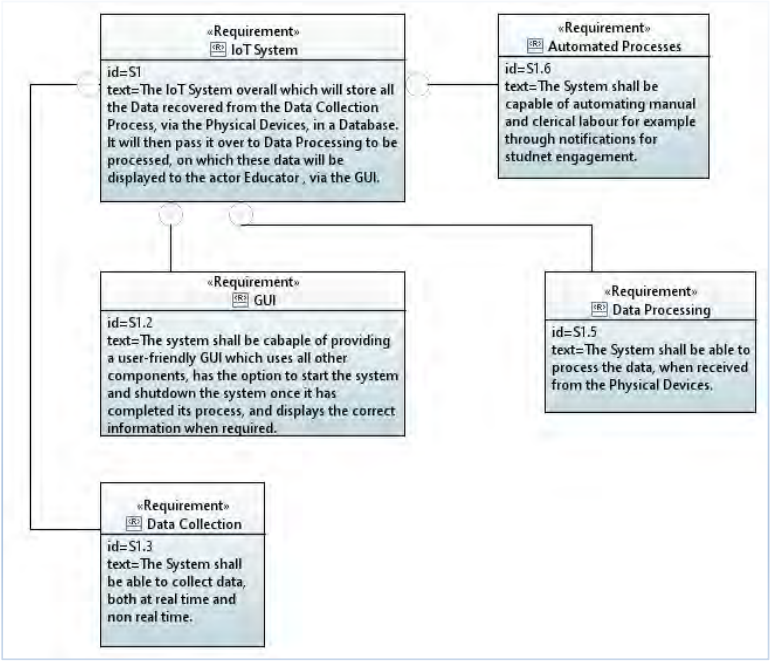

Figure 1: SysML Requirements Diagram – Overall System View

Thisdiagram is a high-level description of the overall IoT system. It consists of four main parts: Graphical User Interface (GUI), Automated Processes, Data Collection and Data Processing.

Specifically, the GUI is the interface for academics/students to the IoT system and has all the functionality required to handle system operations; the Automated Processes refer to all tasks that will be automated as a result of information/data collected through the IoT system (such as notifications to educators for student engagement and performance); the Data Collection (monitoring) is the requirements that will be implemented mainly through physical devices and statistics/programs in VLE environments; the Data Processing (adaptation) is the requirement for processing appropriately all data collected to provide meaningful and useful adaptation suggestions.

4.2 Low-level diagrams – Data Collection Viewpoint

Figure 2 presents a SysML Requirements diagram at a lower-level of abstraction. At this lower-level, implementation decisions are being initiated according to the

requirements diagram, enabling the traceability of requirements. Specifically, the diagram shows the implementation related blocks that <<*satisfy*>> specific requirements such as *Physical Devices* for *Real Time Data Collection*, *Portal* for *Non Real Time* and *Real Time Data Collection*.

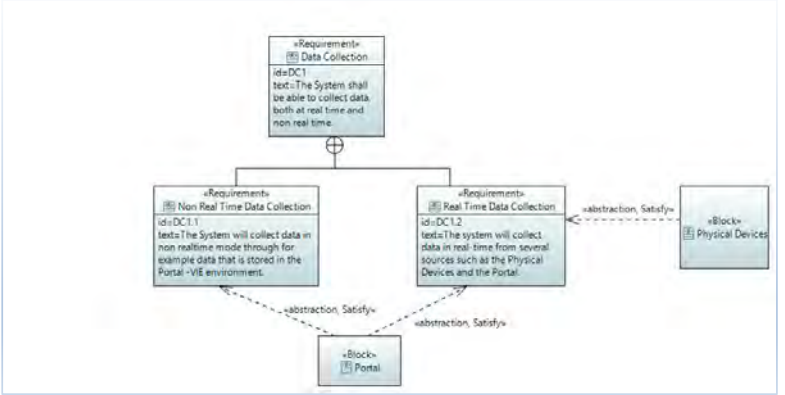

Figure 2: SysML Requirements Diagram – Data Collection

This is the aspect of the system which will rely on the use of *Physical Devices* and the *Portal* to gather data at real time and non-real time modes. For non-real time data collection, information from the *Portal* regarding student attendance and engagement is gathered and processed through learning analytics technologies. For real time data collection, both the *Portal*information and input from the *Physical Devices* are collected and processed at real time. Note that the term real time in this context refers to collection and processing of the information.

Figure 3 presents a SysML Requirements diagram at evenlower-level of abstraction. Specifically, the diagram shows the implementation related blocks that <<*satisfy*>> specific requirements such as *GPS Tracker* for location monitoring, *Portal* interface for students/educators and *Key Fob* for implementing sensors.

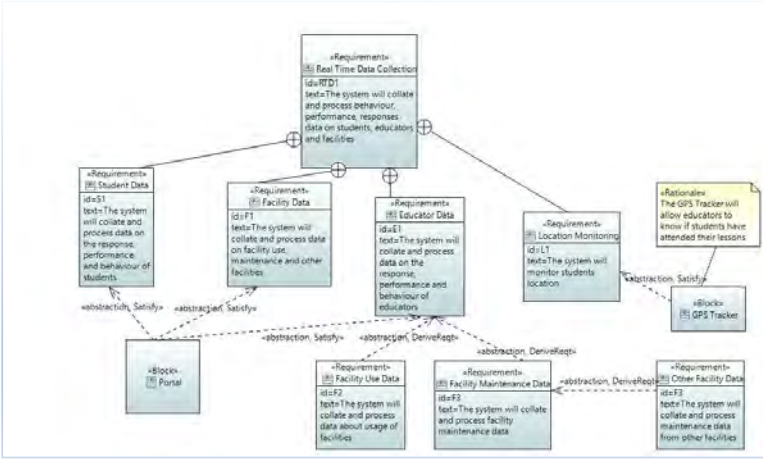

Figure 3: SysML Requirements Diagram – Real Time Data Collection Viewpoint

Additionally, the *Real Time Data Collection* is shown as consisting of *Student Data*, *Facility Data* and *Educator Data*which are collected through the *Portal*. The *Portal* is itself a VLE system, tailored to the interfaced IoT system, ensuring that they work in tandem. *The Portal*can be based on an existing VLE platform, such as Moodle, Blackboard, or Brightspace,customised accordingly, or it could be developed from scratch, tailored tothe requirements of this case study.A *GPS Tracker* is used for location identification for attendance monitoring purposes, as well as energy efficiency. Finally, a *Key Fob*utilising a simple user interface, and containing sensors, will be directly tied to the IoT system.

5.0 Proposed System Design/implementation – Data Collection Viewpoint

The common element in all relevant IoT in education systems that is evident from the background study in Section 2, is the use of IoT for data collection. Therefore, this proposed system is constructed around the Data Collection Viewpoint and is presented in Figure 4.

Overall, the IoT system comprises three main aspects: *Database*, *Portal Interface,* and *Key Fob*. These aspects in turn consist of many key elements, parts, values and operations. As the same time, the IoT system is both used and interacted with by three main Actors: *Students*, *Instructors* and the *Institute's IT Department*. The solution has been designed around their requirements and the university's strategy to support the advancement of personalisation of education.

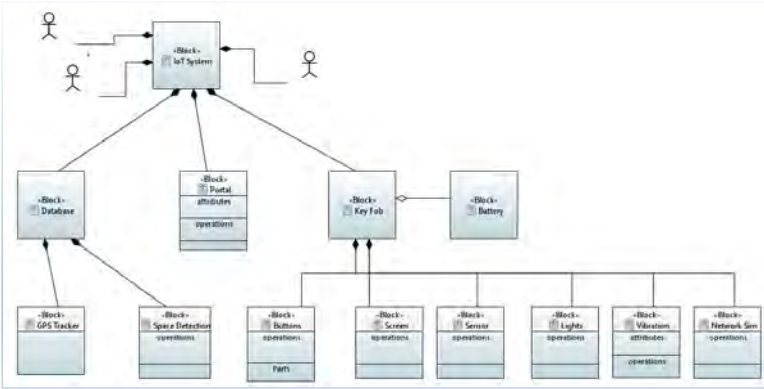

Figure 4: SysML Block Diagram – Data Collection Viewpoint

The proposed system will offer 24/7 operation and will be available throughout all the large lecture theatres and computing laboratories,connected though the existing local network infrastructure. It will allow for real time data collection and processing. The system will also ensure teaching room layouts are detected to process appropriate data according to where the students or instructors are physically situated. Furthermore, the system will deliver data on the behaviour of users occupying any physical space which is being monitored, enabling energy efficiency monitoring. This will include academics, students, and any facilitiesthey use.

The *Key Fob* will be distributed to every student and academic enabling the monitoringof usage behaviour of the facilities available within a given space. The fob will operate autonomously but could also be activated via a button located on the device, enabling manual use. Three main buttons will be present on the device; the first button will turn the device on and off;second will manually enable location monitoring, and the third managing system alert. It will be able to automatically recall the room the student or academics are in using built-in sensors. The *Key Fob*will also allow for alerts and response receiving, with an LED screen being present along with two LED lights that will flash when an alert is received, or an issue arises with the device. The device will vibrate to add another type of notification. Finally, the Key Fob will have a built-in wirelessthat will provide the one-to-one connection with the local network. This will be run at all time as stated above.

The IoT system, integrates two main databases: *GPS* and *Space Detection*. The *GPS* database will manage the location datawhich will be location will be logged and stored for future reference. The *Space Detection* database will provide the

basis for measurements and pre-set configurations of devices to be available. When signals are detected in a room, relevant configuration data will be retrieved on demand.

Finally, the system will contain a *Portal Interface*. This interface will be the main visual interaction means between the users and the system, providing users with log details, and the ability to view personalised data.This would enable academics to review and respond to issues raised throughout the student lessons. As such, the *Portal* will enhance communication throughout its user base, providing a better service and more engaged users.

6.0 Evaluationof the proposed solution and open issues

The benefits of the proposed solution can be seen in various ways. The fact that rich data will be collected and analysed in relevant ways, will enable informed decisions which support the enhancement of the student experience. It is important to acknowledge, however, that the proposed systems require a significant upfront investment, will incur development and maintenance costs, and require the acquisition and integration of new equipment.

The design and evaluation of the proposed solution was based on literature review in IoT systems in general and IoT systems designed for educational enhancements. The next logical step in moving this proposal forward would be to incrementally prototypedifferent aspects of the system in order to test its effectiveness, but also offer the means of comparison with other similar options.

However, there are several issues which need to be addressed at the design/architecture level before moving to the prototyping phase, namely security, accessibility and ethical considerations.

While the implementation of IoT technologies can offer significant advantages, it is not without risk. One such risk which needs to be considered relates to data security considerations. “IoT has already turned into a serious security concern that has drawn the attention of prominent tech firms and government agencies across the world. The hacking of baby monitors, smart fridges, thermostats, drug infusion pumps, cameras and even the radio in your car are signifying a security nightmare being caused by the future of IoT.” [18]. As important as implementing a system like this would be, extreme levels of security must be maintained, especially due to the type of data that would be gathered, most of which would contain personal information.

Apart from security concerns, there are several ethical considerations which should be taken into account. One issue that occurs throughout the use of IoT systems, relates to “Who is the owner of the data retrieved by the sensors of the objects connected to the Internet of Things?” [19]. This is in addition to the issues relating

to data security and confidentiality of personal data. Implicitly, when students accepting a place at university, they provide permission for their personal information to be used in different ways, including statistical analysis, videos/audio participation, among other things. However, the proposed solution creates a new set of sensitive personal data which goes beyond the existing information gathered through conventional means, such as logging onto a computer system or accessing the library systems. Careful ethical consideration should be applied to all new forms of data collection methods, and processing of such data.

A further consideration relates to the reliability of the data, as the outputs of any system can only be as accurate as the data which it uses. Inaccurate or incomplete data gathered by IoT devices can lead to producing erroneous results, which in turn can negatively affect the improvements being sought.

Despite the drawbacks, there is a strong argument to be made about the benefits IoT systems can offer. “The Internet of Things itself is only an intermediate stage: In the future, data, people, machines and processes will be linked in the Internet of Everything”. [20]. With the costs of the IoT systems becoming lower all the time, their potential benefits to improve personalised education is becoming a strong possibility. As demonstrated, the proposed IoT system can be cost effective and beneficial solution to the personalised education aspirations of Bournemouth University, and consequently other HigherEducation institutions.

7.0 Conclusions and Future work

This paper has presented a well thought out solution for the application of the IoT, in a university setting, illustrated bya case studywhich relates to Bournemouth University. For modelling the proposed system, a combination of SysML modelling diagrams, such as Requirements diagrams, and Block Definition Diagrams were used. The solution provided was specifically created as a response to the current trend seen in UK Higher Education,whereby university students are requesting a more personalisededucation as part of their learning and teaching environment. This technologically driven need for customisation in conjunction with advances in IoT technologies, makes the IoT enabled solutions for education a viable future development.

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From Enrolment to Employment: Creating Computing Curriculum for Employability and Entrepreneurability

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Abstract

The Higher Education landscape is changing with the introduction of the Teaching Excellence Framework, and even greater emphasis on retention, student satisfaction, and graduate employability. The 'digital or tech' sector has grown exponentially and yet not all computing graduates are able to secure graduate employment within six months of graduation. This paper discusses steps that can be taken to improve computing graduate employability from enrolment to successful employment. These include the emphasis on soft skills, preparation for becoming entrepreneurs, also aligning courses with SFIA+, external qualifications, and placements that can offer opportunities to obtain the BCS Registered IT Technician status.

Keywords:, Employability, Soft skills, Professional Qualifications, SFIAplus, BCS RITTech

1.0 Introduction

It has been recognised from various sources, that there is a shortage of students entering the technology and engineering profession, so that the current and future needs of the UK for graduates with these specific skills, could not be satisfied [1, 2]. Various surveys have been undertaken, both through the Government and professional bodies, particularly those from the technology sector, that have confirmed the shortage and the need for more technologists. The Scorecard 2016 [3] specifically identified the shortage of computer professionals and that only a small proportion, 17%, of those in the industry are female. It also indicates that a large number of computing professionals are interested in starting their own companies.

2.0 CV and Additional Activities

To assist the students with employability, they need to work on their CV from the second year of the undergraduate course. In addition to producing it in a professional manner, with key information at the start, the students need practice on reordering their CV and producing covering letters, adjusted for different job applications.

While at that stage of the degree course, they need to understand the potential benefits in being able to include and later discussing their hobbies, their involvement with professional societies and with voluntary activities. These various aspects can enhance their application to make it of greater interest to potential employers. For example, by starting a students' union club, they could show initiative; by holding a senior elected committee role in such a club, they could show potential managerial skills. Involvement in professional societies, such as the BCS, The Chartered Institute for IT [4], could indicate interest in the subject area, beyond "just the course", and could indicate the student wishes to become aware of new developments which might be of potential use to an employer. It would also imply that the student was learning to network. An example of this was one student, this year, who attended a BCS workshop. As they were working in pairs, his "partner" towards the end of the session, told him about and encouraged him to apply for the partner's company's graduate scheme. Often students at such events can gain confidence, meeting and perhaps working with senior members of their profession.

3.0 Soft Skills to Assist Employability

The employers have reported the need for computing students to have soft skills [5]. These skills can be encouraged by making presentations as an assessed element of many of the course units. Often students are only concerned with the more technical aspects of their course, but these technical skills are only relevant in many cases for a short length of time, whereas the communication skills (of

listening, spoken and written communication) also networking would be useful to the student throughout their career. The disadvantages of including a presentation element or a viva session on other assessed work, is that it can take a considerable amount of class contact time. By asking the students to submit their presentation as a YouTube or similar file together with their PowerPoint file, this allows the lecturer to check the layout, and content of each slide. The class time of this method can be reduced, but this still takes the lecturer a considerable amount of time, in addition to lacking the direct presentation and live questions session at the end of the presentation. A combination of the prepared and the live presentations would provide students with excellent practice, for job interviews, which sometimes require the candidates to make such a presentation.

An exercise undertaken by Ross, was to separate the class into teams of three or four, who would devise a job advertisement and job description. Members from another team would individually apply for three jobs, modifying their CV and producing relevant covering letters for each job. Each of these students would then pass their covering letter and CV to the "employing" team who would then plan their questions for the job interview, then conduct the interview for the advertisement with three interviewees. This provided students with the experience at least three times of answering as well as asking potential interview questions. The disadvantage of this was that the lecturer, Ross, was only able to spend a short period observing and possibly commenting if necessary with each team. It was only possible to spend time to provide a general set of comments relating to the conduct of the "interviewers" and "interviewees" together with discussing alternative responses to some of the "answers" [5].

4.0 Professional Qualifications

It is possible to align units to external professional qualifications, which the students can take, possibly at their own cost as a part of or separate to their unit assessments. An example of this at Southampton Solent University is the Cisco qualifications [6] for students on networking courses. Students on various business courses can take the Prince 2 Foundation qualification [7]. If the external qualification is separated from the normal unit assessment, it is wise to ensure that the syllabus for the external qualifications is covered within the course unit and ideally both assessments styles of the unit and external qualifications are compatible.

Another example of this was the BCS SSADM (Structured Systems Analysis and Design Methodology) external examination, offered to Ross's students. These students took the normal unit assessment, then for the following two weeks, an external full cost course was held for systems analysts. At the end of this intensive course, the written examination was organised for the course members, who would be joined by the university students for the same examination. This examination had been set through the BCS so it was not seen by the candidates or lecturers of the university until the papers were opened at the start of the examination.

Following the conclusion of the examination, all the scripts were marked while the course candidates and university students were briefed about the individual vivas on the following day. Two external examiners were sent from the BCS, firstly to check the marking of all the scripts, then to hold vivas with each candidate and student in turn. The benefits to the students were considerable. The disadvantages to the staff was marking the final students assessed examination while running an intensive short course and then the pressure of very fast marking of the combined candidates and students professional examinations scripts.

Other professional qualifications that could be aligned with computing units are ITIL [8], BCS Business Analysis [9], BCSAgile [10]. The methods of assessment for these qualifications are often multi-choice at the Foundation Level and written, possibly linking to given case studies, for the Practitioner level. The university would need to apply to be an accredited centre for the relevant qualifications, requiring a centre cost, also examples of suitable material and of staff to prepare students for these qualifications together with suitable facilities. All of these should normally be provided by the relevant university courses. By providing students with external qualifications, this could confirm to potential employers that these units were of the standard, breadth and depth of the professional qualifications, of which the employers were already aware. This could be of major benefit both to the student as well as improving the reputation of the university.

5.0 SFIAplus

Many organisations in the UK are aware of SFIAplus [11] which provides the career structure for both individuals and for planning within organisations for their IT staff and staff in future IT requirements. By aligning a degree course with aspects of the SFIAplus structure, the skills gained by students could be immediately understood by potential employers. It could also be very useful in planning a degree course, together with potential follow up MSc and full cost short courses.

The SFIAplus identifies the progression for a wide variety of 97 IT roles or skills, from technical to business and to educational. There are 7 levels that range from a new employee possibly with "A" levels, to after successfully completing a computing degree, level 2 (or with a placement could be at level 3), through roles of project management, IT departmental manager, to Executive of a major organisation (level 7). For example, the Testing role ranges from level 1 to level 6 whereas the Business Process Improvement role is from level 5 to level 7.

For each level, for the different roles, the appropriate levels are specified, so that for a particular role, a person would have to reach a certain level at a minimum. For each role at that specified level, there are specified skills required, tasks that could be expected to be undertaken, relevant qualifications, and wider knowledge. An example of the latter would be at the lower levels, when a person would be expected to understand the working of their section or department. As the level

increases, the understanding expected would progress to the workings of their organisation, of their industry, to the wider global implications. At the highest levels, the person might be a committee member of possibly an International Standards Committee, Professional Body, or regular invited keynote speaker at national or international events. By linking degree courses to the SFIAplus structure, students are encouraged to consider not only their initial potential employment in industry, but to begin to take control of their long-term planning of their careers.

The SFIAplus structure was included in the curriculum for students at Southampton Solent University, and a survey [12], was undertaken to obtain the views of full time students on SFIAplus. The results were as follows:

- Do you understand how SFIAplus relates to employability - 27% agreed
- Could you identify a single role (or roles) that could be relevant to your future job – 67% agreed
- Could you see the benefits of a structure such as SFIAplus - 27 % agreed
- Would this help in identifying the skills when applying for a job or promotion – 59% agreed
- Would this help to identify the possible technical courses to request to attend for annual appraisals with a view to future promotion - 53% agreed
- Would this help in identifying the possible other non-technical activities to participate in with a view to future promotion - 46% agreed
- Could this help in assisting with your annual appraisal - 41% agreed
- Could this help in assisting in preparing a covering letter for a job application - 67% agreed
- Could this help in assisting in preparing your CV for a job application - 66% agreed
- Could this help with long term planning of your career and, possibly involving a slight change of direction - 53% agreed

In addition, these full-time students were asked to identify disadvantages, which included "confusing", "it takes a lot of time to understand" and "no one has ever heard of it", as well as the advantages, which included "gaining skills", "broadening knowledge", "pinpoints the right job for you by defining your skills", provides a "better chance of getting a job ", and "reflects the current skills required by the industry".

6.0 Apprenticeships, Placements and Technician Status

The recent development in the UK is the growth of apprenticeships, both at the Further Education level, from the age of 16 years, and of the "higher" apprenticeships. The latter, if completed, lead to a degree via part-time studies.

Various universities are developing special courses, as day release, block release or mainly remote study. These are either designed with a particular organisation in mind, who could supply sufficient students to have a dedicated course, or with a more general curriculum to be suitable for apprentices from variety of SMEs or

larger organisations but with a low number of potential computing apprentices.The "higher" apprentices would have the advantages of possibly gaining three years' work experience, with a salary and no student debt. Also they would possibly gain half or more of a relevant degree, which could be completed after the end of their apprenticeship. These students can sometimes be then offered employment with their organisations. The Government has promoted the concept of apprenticeships so that this will hopefully help to address the shortage of computer professionals.

Southampton Solent University, like many other universities, celebrated the 11th National Apprenticeship Week 2018, with as series of drop - in sessions, breakfast briefings and evening events. The National Apprenticeship Week, which is held normally from about the fifth of March, provides an opportunity for potential, current and past apprenticeship students, their tutors and employers, to exchange experiences. During the 10th Annual National Apprenticeship Week in 2017, over five hundred and thirty events took place. These ranged from business breakfasts, career fairs, open evenings, a webinar involving ten thousand individuals, an event at the House of Commons, and a photo call for apprentices current and past outside 10 Downing Street [13].

Many universities encourage or require students to undertake a placement year, after completing the first two years of full-time study. This normally increases the students' knowledge, confidence and potential employability.

The BCS has recently introduced the registered IT technician status [14], which can be obtained following a degree placement, a suitable apprenticeship or with suitable experience. Evidence is needed that the applicant can

- “use IT knowledge and understanding to apply technical and practical skills;
- contribute to the design, development, manufacture, construction, commissioning, operation or maintenance of IT products, equipment, processes, systems or services;
- accept and exercise personal accountability;
- use appropriate and effective communication and interpersonal skills;
- exhibit professional behaviours and commit to a professional code of conduct”.

A Registered IT Technician would normally have at least a year working at SFIAplus level 3. Undergraduate students on successfully completing a placement year, have obtained this recognition [15], and so can put RITTech after their name, which could increase their employability.

7.0 Encouraging Entrepreneurship

Various activities are being undertaken at London's South Bank University (LSBU) to encourage students, particularly those studying engineering and technology, to consider becoming entrepreneurs. These include subject specific networking opportunities and diversity in engineering events. The results of these

are that one third of the students engaged with some type of entrepreneurial support. These activities can involve "start and evolve" talks where successful entrepreneurs share their experiences in order to inspire students and graduates to consider the next step on their future business journey. There are also "develop and grow" initiatives that support students to develop their enterprise skills and an entrepreneurial mind set. The students can be awarded a "Certificate of Enterprise" for those who have taken part in six of these activities. The university also runs a "Make It Happen" competition for students, to allow the winner to develop an idea. The prize for this includes free office space and money to start their own business or further develop their concept.

These activities are designed to develop peer support entrepreneurs with subject specific networking opportunities leading to student led consultation, by providing role-models, pairing the students with mentors or coaches and allowing them to gain real world experience. This is helped by actively encouraging relevant societies and networking opportunities and utilising the Alumni connections. The effectiveness of this programme was demonstrated by the 2017 London South Bank University's survey which identified that these activities aimed at engineering and technology students were the group that were most interested in a running their own business in the future (73%) compared to all of the students' (52%). The LSB university, organised with AFBE, UK, the Association for Black Engineers, a two-day "Diversity in Engineering" activity, in which twenty professional engineers and forty LSBU students, took part in one-to-one mock job interviews, an enterprise competition and various talks from a panel of engineers from black and minority ethnic (BME) backgrounds [16].

8.0 New Interdisciplinary Initiatives: Games Jam

A two-day games jam was held at London South Bank University in 2015, combining undergraduate students from the Business Information Technology course and the Games Development course. There were six mixed teams. The Business Information Technology students took the role of consultants on usability and Intellectual Property Rights, while the Games Development students were the clients. In preparation for the games jam, the Business Information Technology students prepared a set of questions to assist in their consultancy role. The first day was spent identifying issues such as the unique elements of the various games that had been developed by the games students. The Business Information Technology students were able to use their knowledge to evaluate and suggest improvements to the various games, especially to increase the usability and marketability of the games. On the second day, working together, each of the various teams prepared and made presentations to the "judges". The Games Design and Development Course Director, Siobhan Thomas, said that "this is a really unique Games Jam because it incorporates accessibility and usability, IP and games developers and informatics students all in one place". One final year Business Information Technology student said that "I learnt how to collaborate with others that were not from my course necessarily. I just learnt how to give criticism but at the same time

keeping a professional manner". Both groups of students felt that this "extra curricular" project developed their employability skills, such as time management, how to listen, team working and also how to give and receive constructive criticism [17].

9.0 Conclusion

In order to address the needs of industry for an increasing number of computer professionals and engineers, in the future, universities need to consider realigning their curriculum in order to prepare their students for a future either as entrepreneurs or through employment both in the computing industry and the range of organisations that are now dependent on skilled IT professionals.

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Using Animations for Improving Learning

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Abstract

Simulation of systems as a research method by experimenting with a computer model of real objects, phenomena and processes is designed to gain new knowledge about them. Visual interactive simulation models can also be used in learning to gain new knowledge for the learner. If these educational computer models are implemented on the basis of exact mathematical models of the phenomena or topic that are being taught, then the simulation experiment can be planned so that the learner, based on his/her own experience of observation, can construct required knowledge. The mathematical model itself is a concentrated form of knowledge about the studied phenomenon. The animation of the modelled process itself is controlled by an algorithm. The visualisation can be realized by eliminating unnecessary and insignificant details and highlighting the features and properties of the modelled object to be observed. Interactive animation-simulation models are successfully used in learning to present knowledge that learners should learn. They support active and creative learning. They are very successfully used as a substitute for school experiments that can be dangerous, expensive, too fast or too slow or unobservable. The effectiveness of teaching with the use of animations based on simulation models is evidenced by our research results at two universities.

Keywords: Entertaining teaching; Multimedia learning; Interactive animations; Simulation experiments; Active inquiry-based learning.

1.0 Introduction

One of the hardest tasks for pupils and students are to learn complex dynamic processes and to understand how they work. Similarly, to understand how the world works by using exact mathematical models or complex functions, which describe the behaviour of the processes under study, seems to be very difficult for pupils/students. However, the exact mathematical model of a dynamic event is a suitable basis, not only for presentation of new knowledge, but also for animations controlled by an algorithm. Interactive visualised and properly designed simulation experiments will enable the user not only to understand complex dynamic processes and phenomena, but also to discover their different properties, thus the learner gains new knowledge based on own observations and experience in the context of the theory of constructivism. Such simulation computer models can be used in all phases of the learning process. They can promote an appropriate motivation for learners through an illustrative presentation of the problem to be understood, solved and learned. The learner can experiment with the model and prove the accuracy of the acquired knowledge. He/she can also enable active use of the acquired knowledge by learning to solve standard and nonstandard tasks in different problem situations.

2.0 Visualised Simulation Models in Education

Teachers/educators can use ready-made freely available simulation models in the classroom. If they are sufficiently proficient in programming and the creation of computer applications, they can design and implement their own models.

2.1 Visualised Simulation Models in Teaching Natural Sciences

Simulation models are particularly suitable for the teaching of natural sciences and technical subjects. The aims of the use of simulation models in this area are to increase clarity and effectiveness of teaching and learning. In particular, they facilitate the understanding of complex dynamic processes, basic functioning principles of dynamic phenomena and the rules of the solutions to a task. By using simulation models the time needed to understand a certain problem and its solution is decreased.

Various education simulation models supporting the teaching of natural science subjects can be found at: https://phet.colorado.edu/en/simulations/ (accessed on 10 March 2018).

The interactive simulation models at this web-site are divided into several categories. The categories are created by defined criteria, as follows:

By grade level: There are four groups of visualised simulation models, Primary School, Middle school, High school and University.

By device: The simulation models are also grouped by device for which they are suitable to be used, including: for iPad/tablet or Chromebook (Computer and

Notebook). These categories are not mutually exclusive. The same simulation model may be implemented for different devices.

By subject of teaching: There are also groups by subject of teaching, such as Physics, Biology, Chemistry, Earth Science and Mathematics.

Special groups: There are also two special groups of simulation models. The new ones and the ones implemented in HTML5.

We can also recognise which one of the simulation models are translated to other languages. The user can thus select a suitable language for his/her learning. In total 92 languages are used. The number of translated items in each language are different (from 1 to 184). The same number, in total 184 simulation models have the following communication languages: (translated from English into) Bosnian, Chinese (Traditional), Danish, German, Greek, Hungarian and Serbian. Only a little less than the maximum of 184 is translated into other languages: Chinese (Simplified) (183), Polish (183), French (183), Vietnamese (182), Spanish (Mexico) (182), Portuguese (Brazil) (181), Dutch (179), Korean (178), Slovak (174), Basque (163), Hebrew (163), Swedish (148), Thai (144), Turkmen (142), Turkish (142), Japanese (140). There are also around 100 other languages available, namely Russian (136), Macedonian (127), Croatian and Czech (125), Turkmen (124), Indonesian (119), Estonian (118), Arabic (110), Belarusian (106), Kanada (105). In 20 languages (out of 92) only up to 10 simulation models have been implemented, of which 8 have adapted only one linguistic model (Data are from January 17, 2018).

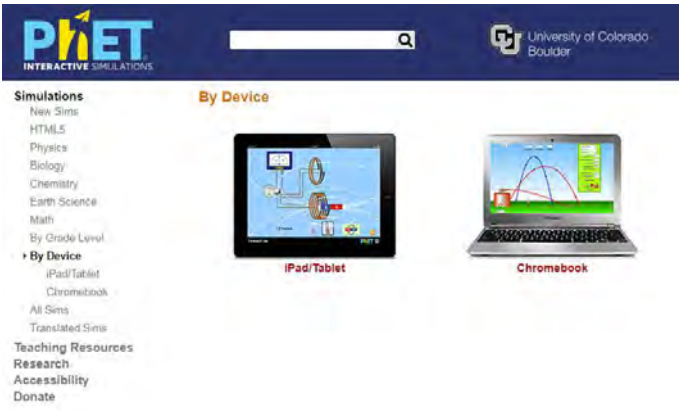

Figure 1. Introductory website of simulation models "PHET – interactive simulations". (Source: https://phet.colorado.edu/en/simulations/)

All simulation models at this web site are very well designed and implemented with an excellent didactic presentation of content – the topic of learning. Based on our experience we recommend every teacher to use simulation models for interactive and entertaining teaching relevant topics. The models are visualised and

allow the users, not only to observe several dynamic processes, but also to make several experiments that demonstrate the influence of different parameters on the results. Simulation experiments are designed to give pupils/students new knowledge based on their own experience of working with the simulation model. It is important that the activities realised with simulation models should motivate for simulation experiments.

Simulation models are not only interesting and useful in physics and chemistry, but also in other subjects. In figure 2, the result of a series of experiments can be seen as a balance of stored objects on a double-weight scale. In the figure 2 it can be seen how to choose or set the individual parameters and values of experiments in an interactive fun way.

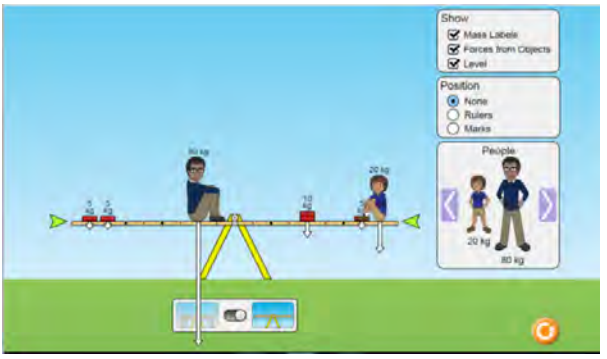

Figure 2. Balancing-act (https://phet.colorado.edu/sims/html/balancing-act/latest/balancing-act_en.html)

All these modes have a high didactic value and deserve the attention of teachers. The role of the teacher in using didactic models is to prepare the work with the simulation model thoroughly. A series of tasks that can be resolved by using a simulation model based on well-planned experiments, should be prepared, thus transforming learning into curiosity-driven experimental learning. When learners spontaneously, on the basis of their own activities and observations, acquire new knowledge about the modelled object and the dynamic phenomenon, understanding of how the phenomenon work is improved. It is also important to combine theory with practice and combine the mathematical model with objective reality. The limited range of the article unfortunately does not allow us to focus on other simulation models that are on this web page. However, each simulation model would deserve a profound analysis and a separate methodological guide for the teacher. Any teacher who wants to increase the efficiency of teaching by using visualized simulation models will discover their didactic potential and find out the suitability of their use. Each model on the site can increase inspiration in the form of topics, description and sample for learning goals (https://phet.colorado.edu/sims/html/balancing-act/latest/balancing-act_en.html).

In the case of the balancing-act computer model there are:

Topics: Balance, Proportional Reasoning, Torque, Lever Arm, Rotational Equilibrium.

Description: Play with objects on a teeter totter to learn about balance. Test what you've learned by trying the Balance Challenge game.

Teachers can make further suggestions at their own discretion.

Sample of Learning Goals:

- Predict how objects of various masses can be used to make a plank balance.
- Predict how changing the positions of the masses on the plank will affect the motion of the plank.
- Write rules to predict which way a plank will tilt when objects are placed on it.
- Use your rules to solve puzzles about balancing.

Projectile Motion

In Figure 3, the result of a series of Projectile Motion experiments can be seen. The main topics in this case are: Kinematics, Air Resistance and Parabolic Curve

Figure 3. Projectile Motion (https://phet.colorado.edu/en/simulation/projectile-motion)

Topics: Kinematics, Air Resistance, Parabolic Curve, Vectors, Drag Force, Projectile Motion

Description: Blast a car out of the cannon, and challenge yourself to hit a target! Learn about projectile motion by firing various objects. Set parameters such as angle, initial speed, and mass. Explore vector representations, and add air resistance to investigate the factors that influence drag (https://phet.colorado.edu/en/simulation/projectile-motion).

Sample of Learning Goals

- Determine how each parameter (initial height, initial angle, initial speed, mass, diameter, and altitude) affects the trajectory of an object, with and without air resistance.
- Predict how varying the initial conditions will affect a projectile's path, and provide an explanation for the prediction.
- Estimate where an object will land, given its initial conditions.
- Determine that the x and y motion of a projectile are independent.
- Investigate the variables that affect the drag force.
- Describe the effect that the drag force has on the velocity and acceleration.
- Discuss projectile motion using common vocabulary (such as: launch angle, initial speed, initial height, range, time).

2.2 Algorithm Animation and Visualisation

One of the hardest tasks computer science students at the secondary and high schools, but also at universities, are to learn programming and to understand algorithms [1]. Visualised interactive simulation models of various algorithms were collected by Végh, who extended them with his own implementation of different algorithms. The included visualised simulation models are freely available at: http://algoanim.ide.sk/index.php by the title Algorithm *"Animation and Visualisation*".

At this website we can find several visualised algorithms from simple to complex ones. The interactive visualised algorithms are divided into a few groups. There are 2 groups of basic algorithms (Fundamental 1 and Fundamental 2),

In the group Fundamental 1 there are 8 simple algorithm animations (Implementation of stack using array, Searching the minimum, Searching the maximum, Mirroring the array, Summing elements, Swapping two variables, Linear search and Simple stack). The group named Fundamental 2 contains 5 algorithms animation (Searching the index of minimum; Searching the index of maximum; Merging two sorting lists; Binary searching and Implementation of Queue using array).

In the next group the best implementations of sorting algorithms are collected. In the group of **Simple sort** there are 3 applications (Figure 4). One of them shows the card sorting; the second demonstrate the sorting columns of different lengths and the third sorts field elements with different numerical values [2].

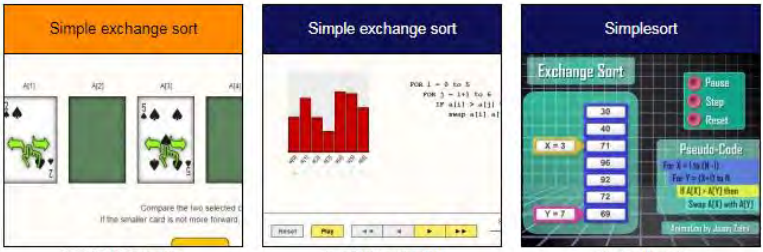

Figure 4. Three examples of Simple sort simulation model (http://algoanim.ide.sk/index.php)

All applications presented in this repository are categorized into one category. Their level of interactivity is evaluated, and the technology used in their implementation is mentioned [2].

2.3 Educational Perspective

The models are created to support all levels of cognitive objectives of learning aiming to lead to deep, useful and applicable knowledge (Figure 4).

The general taxonomy of cognitive objectives describes 7 levels regarding how to handle a topic and to gather knowledge, including: 1 Knowledge, 2. Comprehension, 3. Application, 4. Analysis, 5. Synthesis, 6. Evaluation, 7. Imagination.

Niemierko's taxonomy of cognitive educational goals consists of four levels and is especially used for technical and exact sciences [3]. It includes **Level of knowledge:** 1. remembering; 2. Understanding and **Level of competences:** 3. Specific transfer - application of acquired knowledge regarding presented tasks in standard situations; 4. Non-specific transfer – an application in new and non-specific – real problem situations.

Niemierko's taxonomy of cognitive aims can be transformed into knowledge requirements of the learner. The learner outcomes include the following knowledge that the learning should be able to discern and apply. The learner will be able to:

1) list, reproduce, repeat, name;
2) explain, describe, give examples, say/express by using his/her own words;
3) apply, calculate, demonstrate, quantify;
4) compare, judge, defend, justify, draw conclusions, generalize, etc.

The effectiveness of learning is closely related to the participants' activity. The effectiveness of the different teaching methods was found and demonstrated by Dale, an educational researcher, in the "*Cone of Experience"* ([4]) shown in figure 5. From figure 5 we conclude that the best methods are based on being more reliant on learner activity. For this reason, today's most popular educational methods are all focused on activities of learners such as Inquiry-Based learning, Problem-Based learning or Project-Based learning. At the top of the pyramid less-active methods are found. At this level the learner listens to and reads the learning materials. In order for the educational environment to be effective, action, interaction and

creativity should be introduced. These methods are located at the bottom of the cone. Simulation, simulation experiences and modelling belong to the group of activities from which people generally remember 90 % of what they do.

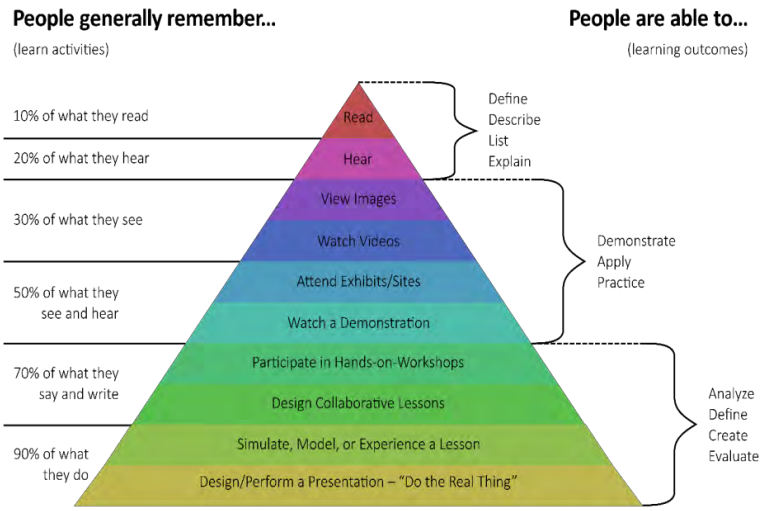

Figure 5. *Cone of Experiences*

Very similar to Niemierko's taxonomy of cognitive educational goals is the revised Bloom's taxonomy which contains six cognitive process dimensions, namely 1. Remembering; 2. Understanding; 3. Applying; 4. Analysing; 5. Evaluating; 6. Creating [5]; [6]. Végh [2] adapted these six process dimensions to the animation of algorithms, as follow:

1. Students know the names of data structures and the names of presented algorithms.
2. Students are able to explain the animated algorithms; they know the steps of them and are able to rewrite the algorithms in a programming language they have learned; they are able to run and test the programs.
3. Students are able to apply previously learned algorithms for solving similar problems, (in different programming environments, or using special input data).
4. Students understand the differences and relations of algorithms solving same or similar problems. They are able to support their arguments and/or prove the correctness of the algorithms. They are able to analyse more complex problems, identify important objects needed for solutions and divide the problems into smaller, manageable problems.
5. Students are able to discuss the advantages and disadvantages of different algorithms solving same or similar problems. They are able to think about

how to modify or combine the algorithms to solve new, more complex problems.

6. Students are able to solve complex problems, where different data structures, algorithms and techniques are needed to be used simultaneously

The taxonomies of educational objectives should also be taken into consideration when developing learning material.

In the next part of the paper, we deal with what factors should be taken into account when developing learning material for algorithms through animations.

2.4 How to Create and Use Algorithms Animation

There are two main categories of tools used in educational algorithm animations:

- *Visualisation systems*: similar to the debugging mode of software development environments including a graphical representation of the data structures and their dynamics and changes of the value of their elements. The source code written by students is visualised. The main advantage is that students can see the processes and data structures of their own code. Examples of visualisation systems are Jhave, Jeliot, BlueJ, ALVIS Live!, Balsa-II, Polka etc.
- *Animations:* The animations, which also may include interactive elements, highlight the individual characteristics of algorithms and focus on the important steps in the algorithms; hence students understand better the visualised processes. Nowadays, animations are developed in Adobe Flash or HTML5/JavaScript [7].

Recommendations related to the graphical design and interactivity of the algorithm animations for teaching were collected from the literature and revealed in [8]. Below the recommendations are outlined.

2.4.1 Design of Algorithm Animations

The design of algorithm animations should include the following elements:

- *Suitable model for representing the data structure - array.* Due to the fact that algorithms deal with abstract data structures, it is important to choose an appropriate model representing these data structures [9] – e.g. the values of elements in an array can be represented by the heights of columns, lightness of balls, or values of playing cards, as shown in figure 6.

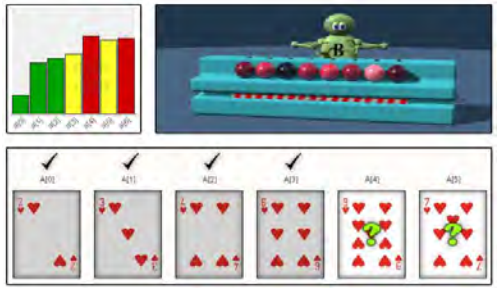

Figure 6. Representation of array using different models

- *Level of graphics' simplicity.* It is important to use simple graphic elements in the animations, which do not draw attention from the visualised processes. Colours and sound effects can also carry information (Figure 6).
- *Algorithms demonstrated on a small data set***.** Previous studies suggest that only 6–8 elements should be used for a demonstration of algorithms. A small number of elements may not be sufficient to illustrate the properties of more complex algorithms e.g. quicksort. Végh and Stoffová, [8], as well as Esponda-Arguero, [10] recommend the use of rather 8-16 and more elements for complex algorithms and for recognising their future (Figure 7).

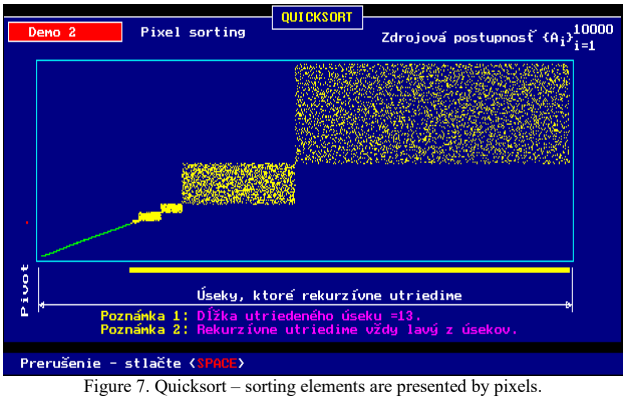

Figure 7. Quicksort – sorting elements are presented by pixels.

- *Animations with explanations*. Explanations (text or voice) may help students to understand easier the visualised data and processes (Figure 7). The explanation does not necessarily need to be part of the animation. It can be an oral implementation of a teacher during the lecture or textual explanation right before the animation in a textbook [11, 12].
- *Different views of algorithm animations.* It may be useful if the animations contain different views for enhancing understanding of the visualised processes, e.g. in one part of the visualisation the animated columns with

control variables of cycles under them are shown while in the other part the source code with the highlighted lines of current steps is shown [2, 13].

- *Showing the source code or pseudocode of the visualised algorithms*. While teaching algorithms, it is better to show a pseudocode instead of the source code, because the pseudocode describes the algorithm at a higher level. Thus, students may learn the algorithm on an abstract level, independently of any programming language; and they will not get lost in the details of the source code.
- *Showing information about the correctness and effectiveness of the algorithms*. Showing the correctness and the effectiveness of the visualised algorithm in some form may be valuable for students when they try to understand and compare different algorithms solving similar problems [14]. Displaying the number of comparisons or swaps in sorting algorithms might give useful information especially for advanced students [15]. A more descriptive solution can be a visualisation of different sorting algorithms at the same time [16]. Such examples can be found at www.sorting-algorithms.com and www.sorting.at websites.
- *Using animations with similar look and control buttons.* Using same models, views, and control buttons in all animations may help students to comprehend the animation.

2.4.2 Interactivity

Several research results suggest that animations are particularly helpful in teaching and learning algorithms in the case students are active participants of visualised processes 17. Visualised simulation experiments have to be planned, controlled and implemented in order to serve to the acquisition and discovery of new knowledge for the user – the student – based on their own observations [11].

The level of interactivity in animations may de different: from a simple observation, through a modification of animated objects to a development of one's own animations. Animations with a low level of interactivity are focusing on the behaviourist-style of learning while animations with a high level of interactivity result in a higher conceptual and procedural learning [18]. Students' participation in visualisation processes may differ as well: viewing, responding, changing, constructing or presenting [19, 20, 21, 22].

Regarding the interactivity of algorithm animations, based on our experience of creating and using visualized simulation models. We can summarize our experience with the following recommendations and requirements: *The control of the animations should be flexible*; *the speed of the animations should be varying; the user should be able to change the speed*. *Modifying or changing the input data in the animations helps students to better understanding of the behaviour of the algorithms Animations should adapt to students' knowledge level, or different animations of the same algorithms are recommended to use; Questioning students during the animations might be useful*. *Animations should be entertaining*. The detailed exploration and analyses can be found in [23].

3.0 Case study

During the academic years 2012/2013 and 2013/2014 a pedagogical experiment related to sorting algorithm animations, took place at J. Selye University in Komarno (Slovakia), and at Trnava University in Trnava. The respondents are 36 first-year computer science teacher training program students from Komárno and 34 from Trnava. The students enrolled at the "Introduction to programming and algorithms" two semester courses. Evaluation of the didactic application was carried out using a questionnaire containing 9 questions with a five-level Likert scale to evaluate its content quality, graphic and didactic site as well as interactivity and control. The application was implemented in Delphi and contains 5 visualised simulation algorithms: Simple Sort, Select Sort, Bubble Sort, Insert Sort and Quick Sort (Figure 7). On the basis of the processed questionnaires, we found that future IT teachers consider visualized computer simulation models to be an appropriate and effective didactic tool (93% of the respondents awarded the highest rating and 7% of the second highest score). Teacher training students - Future teachers recommend other teachers use simulation models in teaching (85% of the respondents very strongly and 15% choose the second highest score). Students rated interactivity, graphic design, and control applications also very positive. (90% of respondents chose the highest and 10% chose the second highest score). The students had minor problems to associate the program code with the changes that were made in the used data structure (array). 30% of students were admitted that during the first simulation experiments they had some problems to understand how the algorithm works.

Considering findings and recommendations in the literature review and own experiences, a collection of interactive animations were developed to illustrate the main ideas and differences between 5 some of the non-recursive sorting algorithms [8]. The collection contains five algorithm animations: simple exchange sort, bubblesort, insertion sort, minsort and maxsort. The animations are available at http://anim.ide.sk/ web page. The aims were to create game-based animations with a high level of interactivity where students have to sort the elements in ascending order by using drag-and-drop operations, but strictly following the rules of the sorting algorithms. The animations were developed in HTML5 using JavaScript technologies. The CreateJS libraries (www.createjs.com) for animating the objects were also used. Same colours for all cards (selected from four different colours at the beginning of the animation) were used for a better understanding of algorithms. Cards J, Q, K, and A were not used to avoid any confusion.

The pedagogical experiment related to these animations, took place at J. Selye University in Komarno (Slovakia), were 92 first-year computer science students enrolled at the "Introduction to programming and algorithms" course during the academic year 2014/15 and 2015/16, were asked to fill in a pre-test, experiment with the interactive animations, and fill in a post-test. The results showed that animations helped students to understand essential aspects of sorting algorithms. However, the participants were not able to understand the sorting algorithms in detail, so other types of animations are needed to teach algorithms in-depth. The sign tests showed that participants were able to mark significantly more correct

algorithm-statement combinations, and fewer incorrect algorithm-statement combinations in post-tests than in pre-tests. However, in the second part of the assignments, where students had to pair algorithm names to their pseudocodes, the McNemar's tests did not show any significant changes. For understanding the algorithms in-depth, more detailed, micro-level animations should follow the animations presented in this paper. Thus, students – after recognizing the essential aspects and differences between the sorting algorithms – can easier start learning algorithms in detail [24, 25, 11].

4.0 Conclusion

This paper presented how animations of algorithms are likely to help students to understand the connections between abstract concepts of algorithms and real life objects and situations. Recommendations drawn from the literature regarding graphical design and interactivity of animations was presented. A case study, developed based on the recommendations, with interactive card sorting animations was described followed by a pedagogical experiment related to these animations.

The results confirmed that animations help students to understand essential aspects of sorting algorithms. They were able to recognize the main ideas of sorting algorithms, but they did not understand the algorithms in detail. The case study proved that the interactive card animations with conceptual view could be successfully used for students to understand the main aspects of basic sorting algorithms and recognise the differences between them.

Future studies will concentrate on comparing knowledge acquired by sorting animation to other teaching methods and other educational materials.

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Using ICTs in Enhancing the Production Qualities of Films: A Reflection on the Nollywood Experience

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Abstract

According to a World Intellectual Property Organisation (WIPO) report, an average of 1500 movies are produced annually in Nigeria by the country's movie industry. This makes it the largest film producing industry in Africa, and globally, second only to Bollywood. Unfortunately however, the rapid growth of the industry in terms of number of movies produced per annum is not commensurately reflected in the level of quality of the products. Between 2014 and 2017 when film aggregators and distributors in the country started prospecting for the international market only about 19 Nollywood films have been acquired by reputable international platforms such as Netflix, the global film market's flagship.

One of the main reasons for this rather poor level of international acceptability is the perceived poor technical quality of these movies. In this paper, we explore the uses which ICT devices and processes could be put to in upgrading the production values and qualities of films produced in Nollywood.

Keywords: Nollywood, ICTs, Production Qualities, Film Production, Reflection

1.0 Introduction

In 2017, the leading African content and programming platform, MNET/Multichoice franchise, scheduled the Big Brother Naija, (BBN), a Nigerian version of the celebrity house-mates show on premium scale. All 12 housemates were airlifted from Nigeria to a corner of Johannesburg's suburb, in South Africa. The shoot and telecast of the prime time show lasted 78 days. Nigerians were shocked,including government officials, who considered it disrespectful.They felt that South African owned MNET/Multichoice management was snubbing Nigeria's supposedly enormouscapacity in content production given its pedigree with Nollywood.In a rather hasty response,Nigeria's Minister of Information and Culture pronounced a ban on shooting Nigerian contents "outside the country" [1].

A full year afterward, with season 2 of the BBN running on prime television, nothing changed. In fact, the celebrity roommates airlifted from Nigeria to a location in Johannesburg increased to 20. Additionally, theprize money jumped by 80% from N25 million (approx.£49,000.00) to N45 million (approx.£89,000.00). Outside of the roommates who are all Nigerians and the programme's brand association and focus on the Nigerian audience, there was absolutely nothing Nigerian about the production set [1].

As a film production market, the local Nollywood home video productions have influenced and captivated a wide range of the African audiences, not necessarily by any adherence to cinematic production quality and values. However, as a production location for quality content,the industry continues to lag. The globally-hyped Nollywood's 2017 production, ***Beasts of No Nation***, was actually set in Lagos, Nigeria [1]. But the producer preferred to recreate an enthralling Lagos community in an Atlanta neighborhood in the United States rather than subject his production crew to the abject lack in infrastructure, and capacity without any strategic,redeeming value-added deliverables.

Thus, this paper examines the role ICT devices and processes could playin upgrading the production values of films produced in Nollywood. In an era of digital explosion, the Nollywood as a contemporary film producing industry was the creation of digital technology. As new digital and technological innovations continue to evolve, it is therefore the contention of this paper that the corps of film producers in Nollywood will greatly benefit the quality of their creative and professional worth by continual deployment of ICT through digital innovations in the processes of their film production.

2.0 Literature Review

According to figures released by UNESCO's Institute for Statistics [2], between 2005 and 2009, India's Bollywood produced a total of 6,304 films, followed byNigeria's Nollywood with 4,961 films; and America's Hollywood with 3,521 films. The figures also show Japan and Chinaproduced 2,081 and 1,863 respectively for the same period.

With the advent of Nollywood, professional film makers in Nigeria schooled in the celluloid art were appalled at what the young generation of home video producers were bringing out and therefore only too eager to keep their distance from all these. McCall [3] acknowledges that the Nigerian home video producers forced their way into the trade and it was therefore not surprising that their movie productions fell outside the paradigms of conventional academic assessment.

Amu cited in Sokomba and Ossai [4], aligns himself with the purist school of assessment in the Nigerian film making space, decrying the evident disregard of quality in the production model in Nollywood. According to him, "The one-man band syndrome prevails:the producer is the scriptwriter, director, production manager, editor. The focus is no longer on quality but quantity".

2.1 The Emergence of Nollywood

The emergence of Nollywood in Nigeria was both an accident and a novelty. It was neither planned for, nor did it connect to any strategic growth plan regarding capacity, skill, infrastructure and the workflow standards. According to Giwa [5], in 1992, an electronics merchant bankrolled the production of a script that emerged as ***Living in Bondage.*** The direct-to-home video that embodied the allures, ritualism and *nouveau riche* exuberances captured the attention of audiences thereby giving birth to what became the Nollywood film industry.

Living in Bondage which was shot in one month on a budget of just $12,000, sold more than a million copies, mostly by street vendors. This gave rise to Nollywood – Nigeria's movie industry! By 2009, Nollywood had surpassed Hollywood as the world's second largest movie industry by volume, right behind India's Bollywood [2].

In fact, according to Igwe [6], even the term 'Nollywood' was coined by a *New York Times* journalist Norimitsu Onishi in 2002 when he observed film-making activity in Lagos, Nigeria. The term mirrors two of the most famous areas of film production: Hollywood

in the US, and Bollywood in India's Bombay. For some, Nollywood encapsulates the array of actors and actresses emerging from the film-making activity in Nigeria; for others, it refers to the collection of the thousands of movies that have been made there.

A lot of researchers have identified various flaws in Nollywood productions. In a critical, even dismissive assessment of Nollywood productions, Trenton [7], stated thatits "production values are deplorable; special effects leave much to the imagination."Madichie [8] as well as Madichie and Nkamnebe [9] listed poor acting and directing, poor sound quality and lack of creativity, as some of the negative issues affecting Nollywood. Oguine [10] also adds that several foreign and local critics have condemned Nollywood for unoriginal plots, poor dialogue, and poor production values. The quality of the narrative
Apejoye [11] quoted Mick LaSalle, a senior film critic in San Francisco, as stating that for a film to be seen as quality it must be topical, embodying timeless human values, great performance, must have an overarching consciousness or personality that brings the movie into a balance, it must contain at least one memorable scene, it must end in the note of complexity not just ambiguity. Apejoye also added that content, thematic import, sound, light, cinematography, visual elements, director's approach (style of directing) etc make a quality film.

An industry assessment report commissioned by the World Intellectual Property Organization (WIPO) written by Aft [12] adjudged the UNESCO report of 2009 Global Cinema survey that placed Nollywood as the second biggest film industry behind Bollywood of India and ahead of Hollywood of USA as "erroneous." It recorded how that"many practitioners told us that they are tired of hearing it when they know that by most comparisons the industry has a lot of catching up to do to become a world-class industry." The study highlights production issues that bedevil Nollywood, including skill gaps, quality standard level that trails far behind acceptable international quality, production model that prioritizes low budget, and inadequate training windows.

Today, Nollywood films are available globally on cellphones, Netflix and YouTube, and on streets across Africa. In her new book, Witt [13] argues that Nollywood is positioned to become a global brand much like the films of Bollywood or Kung Fu movies of China. This optimistic prediction is despite the many obstacles filmmakers might face: electricity cuts, fuel scarcity, political instability and more.

Witt's book also addresses the major shifts in Nollywood: how the changes in Nigeria's film distribution model affected both the content

and the industry's digital future, among other topics. Witt, who spent five weeks in Nigeria researching *Nollywood*, seamlessly blends travel writing with cultural and media history for a product that is as informative as it is effortless to read."

Indeed, quality standard issues in respect of Nollywood's content have constituted a major source of anxiety for distributors who prospect the international content market. One of such distributors of Nollywood content in the international content, Izu Osuigwe, an international aggregator of Nollywood contents and CEO of Forest Media, frowned at a situation where, after submitting the master, the distributor could get an email from the prospective buyers or licensing platforms "expressing regrets and rejection arising from a noticed audio drop at the 74th minutes, 31st seconds of the movie."

Evidently, there is no quality standard laboratory that runs a check on contents before rights owners could negotiate with platform owners regardingNollywood contents in the international film markets. Usually, the quality standard check list would comprise meticulous adherence to cinematographic qualities, not excluding sound quality, lighting, and picture resolution. Sokomba and Ossai [4] acknowledge that the Nigerian contemporary video film making prowess has garnered international attention, an indication that "this alternative medium of film entertainment has come to stay." Nonetheless, they accept that "close observations of the Nigerian video films will show that a lot still has to be done in the area of effectively communicating messages to the audience." It is generally agreed that the industry is poor and therefore the limit to how far it can go in respect of career development and technical quality of production is hugely limited.

They also highlight that film makers retain a certain power to determine the outcome they envisage from their audiences in what is called "defined process message." On a recent chat-room conversation dedicated to industry professionals, Uzo Okpechi, one of Nollywood's respected directors warned that filmmakers should desist from taking their audiences for granted. "Audiences yearn for quality – in story telling technique. Never allow your audience get ahead of your story. Never allow them get ahead of your plot." Afolabi [14] references one of the attributes of the high incidence of technical deficiencies in films produced in Nigeria and large parts of the African territory.

A survey revealed that in most African countries, the majority of scriptwriters, performers (actors/actresses) and producers do not undergo formal professional training in the arts before getting into film production. In most cases, all it requires to make a film is some

modicum of talent and most importantly, availability of funds to execute the video-film project.

As an industry, the filmmaking processes in Nollywood have followed but not necessarily absorbed the lead and leaps of technological developments. Technology has advanced the course and pace of development in film production, thereby revolutionizing from the 19th Century era of silent movies to a wholesome scale in all aspects of the production processes namely, cinematography, lighting, audio recording and editing.

On a global scale, the concepts of the Computer-Generated-Imagery (CGI) and Computer-Aided design (CAD) have pioneered more efficient production processes on film sets. Sheldon-Hicks [15], in the international digital edition of *The Guardian*, traced the contributions of technology in advancing and making film production more efficient in Hollywood, particularly highlighting the use of CGI and CAD software in the set designs of films like ***Zero Dark Thirty, Fast & Furious 6,*** and ***Guardians of the Galaxy***. He specifically highlights the enormous benefits that come with digital communication such as the possibility of collaborative and joint productive activities between film makers across the globe where movies are shot in one country and enhanced technically in another.

In the same vein, Matthau [16], argues that technology has impacted profoundly on film making particularly with the advent of the digital technology devices and innovations. He highlights the impact of technology on production speed, cost, editing, shooting and preservation among others.

As a low-budget-content producing industry, it is not surprising why Nollywood is fully interested in digital production processes. The digital processes are far more affordable than what celluloid era of productions can offer. The digital editing software allows editors to work on entire sections of a film, easily piecing scenes together after the post production effects are added in. That includes audio, which now has a high definition digital file that ensures the audience will hear every word and action that they see. The end result is a piece of film that looks cleaner, with effects that blend seamlessly with the movie. The audience usually cannot tell when CGI has been used, but it's a powerful tool film makers have increasingly used to set atmosphere.

Digital technology in film production provides the shooting flexibility that allows for multiple camera run, so you get your choice angle without having to do retakes. Equally, digital films can be stored on servers without taking up too much space. Digital archives are easy to

back up and restore. Several producers in Nollywood who have produced some classic stories in the past such as ***Living in Bondage, Osuoffia in London*** confess that they do not have any copy of the movies stored anywhere currently. For self-trained producers and self-funded productions that are prevalent in an industry such as Nollywood, it is helpful to use the windows made available by today's technology to network, learn new tricks and pull ahead of the game.

Advances in online technological innovations make it possible for filmmakers to acquire new knowledge on video pre-production and other technical skills for low budget films with little or no extra payment. Some of the online hands-on tutorials highlight issues such as keeping your budget down while pushing the production values significantly up enough to attract the big buyers from outside of Africa. Chris Ekejimbe, CEO of 4Screams Limited, a post production company in Lagos Nigeria, is a proponent of this model and has argued that the only way open for Nollywood producers to break into the global big league of quality productions is to embrace evolving and contemporary digital technological advances. Ekejimbe gives examples with a few South African low budget productions that have broken into the global big league such as ***I Number Number; How To Steal 2 Million,*** etc. Obi Asika, the CEO of STORM and co-convener of the annual Lagos Social Media Week, wonders though how the application of technology can enhance acting in Nollywood. "We have a major problem with our acting and it will hold back the expected cross over. Many of our talents over act and indulge in histrionics, some even pure caricature," asserts Obi.

This paper draws its theoretical basis from the Development Media Theory [17]. It is necessary though to briefly reflect on the idea of media systems before narrowing on the Development Media Theory because media systems conceptualized by scholars gave rise ultimately to the theory. The concept of media systems was first propounded by Siebert et al [17] in their pioneering and seminal work. The idea of the press in the work included radio, television and film and how the political environment under which these platforms operated were determined by the system in place.

The Development Media Theory is an offshoot of reviews and interrogations of earlier scholars who argue that earlier models may not reflect different cultures and societies that have different principles and priorities. This Development Media Theory was propounded by McQuail [18] and seeks to reflect a symbiosis between the media and the state or government for a central reason of advancing socio-economic development of the state. He argues that the media should have the fundamental obligations of advancing the national objectives of political stability and economic growth and as

such the freedom advocacy of the media should be subordinated or regulated in a manner that nurtures the state's autonomy and promotes indigenous cultures.

Under this theoretical frame, argue the scholars, the media must accept tasks that advance positive socio-economic development of the state; the media must prioritize issues and focus on themes that touch on the lives of the people. They also propound that the media must act in the overall interest of development and must be ready to be subjected to regulatory and oversight duties by the state where necessary.

Nollywood opens for Nigeria the window of the highest export potential of the country's cultural products across Africa and the rest of the world. It stands inevitably as Africa's most profound response to the long-drawn argument over the imbalance of information flow and disproportionate access to the cultural products between the Northern and Southern hemispheres. It offers a high level of employment opportunities which in turn address significantly the issues of poverty, empowerment and career fulfilment that are at the root of development conversations.

3.0 Research Methodology

3.1 Methodology and Design

The multi-method of research was applied in this study to obtain the data that is most appropriate, credible and relevant for this topic. Scholars have over the years applauded the multi-method of research approach as very central in offering a study the most relevant options in design and instrumentation in the process and approaches to obtaining empirical results in a research by Morse [19]; also by Creswell et al, [20].

This paper adopted a combination of the archival records, literature, as well as interview approaches. Morse [19] recommends that in an enquiry into a homogenous research population as few as five interviewees are enough to give saturation to the study. The archival records as applied in this study draw from official documents, and published industry data and reports. Official platforms and guilds representing stakeholders and professionals in Nollywood have over the years expressed anxiety over production gaps in such areas as professional skills, production upgrade and training opportunities. Arising from some of these concerns and outcries some agencies of government with direct oversight responsibilities to the Nollywood industry, namely Nigerian Film Corporation (NFC) and National

Film and Video Censors Board (NFVCB), often facilitated training opportunities. NFC, for instance, runs the annual ***Shoot*** programme that exposes participants to the best strategies and tricks in deploying digital cameras.

This study interviewed 20 movie professionals across five specialist areas in the Nollywood industry (with 5 being selected from each of the specialist areas). These are editors, directors, scriptwriters, producers, and actors. The authors obtained and analysed their views to make a coherent collage of what the Nollywood production reality presently reflects.

3.2 Findings

Using structured interview approach, we sought the views of the selected sample on a variety of the issues affecting the Nollywood industry based on literature and archival materials. This was followed by a thorough cleaning up and analysis of the data to make coherent meaning from them.

As seen in Table 1, we obtained and arranged data from the professionals regarding the factors which contribute to the noticeable poor quality of Nollywood movies if compared to those of Hollywood and Bollywood.

Table 1: Identified Causes of Poor Quality of Nollywood Films

No of Interviewees Who Identified Factors	Factors Contributing to Poor Quality of Nollywood Films	Interviewees' Scores (%)
12	Poor Funding	60
14	Lack of Technical Equipment	70
18	Poor Technical Skills	90
17	Urge for Quick ROI	85
6	Poor Scripting Skills	30
7	Poor Infrastructure	35
13	Inadequate Training	65

4.0 Discussions

To meet today's global best practices in film production values and standard, the film makersare required to pay attention to details. They

should be resourceful enough to continually invest in developing their knowledge and skills. ICT is regularly helpful in addressing this. Technology has defined the roadmap and terrain for the emergence of Nollywood. Yet, delivering consistently to the global market, films that navigate the template seamlessly has remained a tall order for Nollywood. Clearly, from interactions and interviews with established producers in the industry, the challenge is mostly skill gaps among practitioners. It has often been observed that because Nollywood is a low budget film producing industry, the resources are hardly available to foot the requisite cost. And even when the right equipment is available, the skills to sufficiently exploit the technical capacities of these tools are lacking.

A few low budget films produced within Nollywood in 2017 deflate this position significantly. For instance, ***Hire A Man; Tatu; Picture Prefect; Alakada*** etc utilised very low budget to deliver what has been acknowledged as impressive work. In fact, ***Hire A Man***, was produced with N4 million (just over £7,400.00) with additional N3 million (approx. £5,500.00) committed to Publicity and Advertising (P&A). It went ahead to make a successful cinema run, grossing N49 million (over £90,700.00). But practitioners in the industry are quick to point out that cinematic experience and profitability are two separate ball games. Most producers and other practitioners in the industry are motivated by a compelling desire to make money rather than to make an enduring career impression.

Career pay for cast and crew in Nollywood is rather low when compared with South Africa and perhaps Kenya. Professionals who have paid their dues in the industry like KeneMkparu, the CEO of Film House Cinema contend that closing the skill gaps and deploying ICT innovations are very likely to guarantee both cinematic and profitability values. Oliver Aleogena, a notable producer and director contends that the major problem with Nollywood is the low-level skill running the industry. “The crux of this matter here is that it takes immense skill to make a N4 million film that actually looks and qualifies as cinema and not tele-novella. Fact is those skills are not readily available in Nollywood.”

A most notable institutional step in closing the skills gap as well as deploying relevant ICT in the film production cycles in Nollywood is the one taken by the Bank of Industry (BOI), a development-driven investment banking service. Having funded three major production and post-production platforms with contemporary ICT-driven film production equipment such as Kingsley Ogoro Productions, and 4Screams Limited producers in Nollywood, mostly those accessing BOI production funding are compelled to hire equipment from any of the platforms. Nonetheless, international quality standard laboratory

for ticking the quality standard boxes of films produced in Nollywood are not available in Nigeria to serve the industry. So, producers have no way of cross checking on the value delivered on their work within Nigeria by post-production studios in Nigeria until they deliver their movies to prospective licensing agents or platforms in Europe and America before learning of a defect in quality or the other.

The guilds are not strong and forward looking enough as to create professional training and retraining collaborations from which their members could benefit from. Much of the training windows offered have come from agencies of government and international organizations such as the Federal Ministry of Finance's midwifed PROJECT-ACT initiative that trained scores of producers, directors and screen writers in the United States of America and India a few years ago, NFC that offers ***Shoot*** experience and Google. Similar challenges repeat in pictures, audio, and lighting. Most Nigerian productions can adjust to international quality compliance standards.

5.0 Conclusion

This paper set for itself the objective of reviewing the production processes in Nollywood with a view to determining how the use of ICT could be of more significant benefit in advancing the production values and quality standards of films from the industry. The paper identified that indeed innovations in digital technology created the opportunity in the first instance for the emergence of Nollywood as an industry. The paper equally identified enormous energy and enthusiasm in practitioners to use the platform of digital devices and systems to tell their stories for the central motivation of being gainfully employed and attaining some level of social relevance in society.

However, given that the over-riding motivation seems to be focused on lifting practitioners out of the debilitating poverty circle, most producers, scriptwriters, directors and cinematographers are driven more by a desire to make money for themselves than to leave a career legacy through professionally ennobling and inspiring work. This mind-set among the industry practitioners has not significantly helped matters in driving a hunger for global professional competitiveness. The few who are driven by professional excellence have regularly gone out of the general mould to seek out training opportunities across the globe and inevitably pay their way through these.

In instances where these are evident, it shows in their work as well as in their desire to hire or deploy more ICT applications and innovations to make their work more internationally competitive.

There is a consensus that when producers, directors, editors and cinematographers give in to new learning modules as well as deploy innovative skill sets through ICT applications in their creative work, not only do they benefit as individuals, the industry equally benefits and steps up by some notch in the global competitive index within the film industry.

Finally, this study is still on-going as this report is only based on the pilot study. It is the hope of these researchers that as soon as the full study is accomplished, the findings would be shared with this conference, if given the opportunity to do so.

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Experiences of Chinese Students Studying at Southampton Solent University

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Abstract

The paper discusses the motivation of Chinese students, studying STEM subjects at Southampton Solent University. The need to alleviate the worldwide shortage of STEM professionals are considered. The views of some Chinese students, and of their parents, from a 2018 survey are discussed, as are those of a few Chinese lecturers that visited Southampton Solent University.

Keywords: STEM shortage, Chinese students in the UK, Chinese students' views, parents' views.

1.0 Introduction

There is a serious shortage of STEM professionals both in the UK and in many other countries due, in part to the increasing age of many

STEM professionals and the lack of interest by UK students in STEM subjects [1].

Various actions have been taken to address this lack of interest in STEM subjects in the UK. These include new syllabuses and the active support of CAS network [2] to encourage both primary and secondary schools towards IT. Various competitions are organised by professional bodies, such as the BCS, The Chartered Institute of IT, to elicit entries from primary to HE education establishments. Examples of these are the BCS Specialist Groups for GreenIT, for Animation and Games Development, and on 3D printing.

The increased publicity for the 2018 Year of Engineers in the UK has raised the profile of STEM subjects, together with television documentaries and the increased use of scientists to participate in television programmes aimed at the wider mainstream audiences. For example, Professor Brian Cox OBE has appeared in a variety of radio and television shows.

2. Students from Abroad

Over the years, overseas students have attended British universities to complete their degrees, either by attending a UK university campus based in other countries such as China or Malaysia, or by attending a university degree course in the UK for either the full duration of the three or four years degree course, or for the final year to be spent in the UK.

2.1 Students from Germany.

Such an arrangement has been made for a number of years between Southampton Solent University and Bib in Germany, which also involved developing joint research projects [3]. In this case, the first two years of the Bib course were aligned with the comparable units at Southampton Solent University, then the students came to Southampton to complete the final year of their BSc in Software Engineering and received a degree from Southampton Solent University. The students were almost all highly motivated to increase both their technical knowledge as well as their spoken and written use of English.

2.2 Students from China

Since 2015, increasing numbers of students from Jiangsu Urban and Rural Construction College, China [4] have joined a final year full-time course, leading to a degree such as in International Construction Design and Management at Southampton Solent University. These courses are

also designed so that the previous years of study in China are compatible with those undertaken by Southampton Solent University students in the previous years of their degree course.

These Chinese students have identified that there are different approaches to learning between China and the UK. Small surveys were undertaken with the students in 2015/2016. These indicated that more technical book based work was undertaken in China, compared to the problem solving approach at Southampton Solent University. The students found that the use of group working, case studies and case histories and the softer skills such as relating to primary research and presentations and also in preparing students for future employability such as preparing their CV, was viewed as more important at Southampton Solent University than at their establishment in China.

To assist the transition for these Chinese students, senior lecturers regularly visit China to re-enforce the links between the two academic establishments in order to ensure that the students have the appropriate underpinning knowledge, both technically and culturally, to make the transition to the UK. The parents as well as potential Chinese students have the opportunity to meet the Southampton Solent university lecturers during these visits.

2.3 Visiting Lecturers from China

Over the years, a number of Chinese academics have come to Southampton Solent University for extended visits of up to a year, to participate in joint research, to familiarise themselves with British teaching approaches and culture.
An example of this was Professor Xueming Wang from the Ningxia University, China[5] who spent one year at Southampton Solent University, to improve both his spoken and written English as well as to participate in joint research activities, which led to a joint published paper [6].

To further strengthen the links between educational establishments here and in China, three lecturers from Chinese Higher Education colleges have visited Southampton Solent University for periods of up to a year. These Chinese lecturers attended the appropriate classes with their students. This is particularly beneficial, not only to increase the visiting lecturers knowledge of the university, and our learning approach, but also of Southampton, the UK and its culture. The main disadvantage is in the long separation of those lecturers from their family and friends. The main advantages included gaining experience in speaking, writing and understanding spoken English and culture. All of these lecturers from China had never previously visited the UK or another English speaking country. In addition, by attending the classes with the Chinese students, the Chinese lecturers could understand better the British style

of teaching and assessment, so in turn, could prepare future Chinese students prior to their arrival in the UK.

The visiting scholars were asked why they thought students were coming to the UK to study. Two of the three replied. One of the scholars felt that the students wished to 'upgrade their certificates and experience a different kind of life style.' While the other scholar felt that the UK's history and culture was a big draw. An addition they concluded that 'many celebrities in the world are born in Britain and English is a world language. All of these attract the majority of students.'

Our visiting scholars were also asked why they had come to Southampton Solent University and what they have gained or wish to gain from their time here. Both of them talked about co-operation and an opportunity to experience a difference teaching ethos and method. They felt they would be better able to advise future students wishing to study in the UK; they will be able to give information about the different teaching methods and encourage them to consider furthering their education in the UK. It was felt by one that there is a definite benefit to the visiting scholar's career, as "No matter which country you go to, it will help anyone's career. Especially to some developed countries, such as Britain or the United States, will be more helpful to yourself.

You can help yourself to broaden your horizons. Through observation, you can learn a lot of things you cannot learn from books". Also the extended visit can "transformation of the way of thinking". The different cultures of the East and the West provide an opportunity from mutual understanding and learning from each other. The main reasons for lecturers to come to the UK were identified as "the needs of the development of individual business", "lifelong learning is a very important thing" and that "mutual communication and learning from each other can solve many difficult problems". The main reasons that lecturers might not wish to come to the UK were perceived "problems of public security" and "personal safety". Also "for the developing countries, the high cost of living has prevented many people who want to come to Britain" in addition to "language communication problems".

Both visiting scholars felt that the interaction between the two countries strengthened interest in their industries (Construction and Design) both in China and the UK. 'The collision between different cultures will produce many good ideas. This often becomes a source of learning motivation and interest'.

3. Views of Students and their Parents

A survey was conducted in 2018 with a small group of nine Chinese students who had all arrived for the first time in the UK in Southampton, at the start of the one-year course, to complete their degree at Southampton Solent University.

In addition, the parents of eight of the students were also asked to complete an almost identical survey, in order to identify potential differences between the parents' views, and the views of their offspring. The surveys were anonymous and due to the small sample size, no information of gender or age was taken. All the students had previously attended the same Higher Education establishment [F] in China, but with different major subjects. In all cases, the students were the first in their family to study in the UK, although one of the parents had a distant cousin who had done so. The students had first considered coming to the UK between the age of 18 and 20. They had finally decided to come to the UK between one or two years later. The parents had considered this for one to three years before making the final decision to allow their children to come to study in the UK at Southampton Solent University.

3.1 Influences

For the students, the major influence on the decision to study in the UK was their parents (56%). For the parents, it was that their children wanted to come to the UK (38%). Another influence that affected the decision of the students(33%) and also of the parents (28%) were the teachers. The friends who had already studied in the UK were an influence(33%) for the students. For the parents, other children that had studied in the UK, or the parents of those children that had studied in the UK, were an influence(25%).Both the students(22%).and their parents (25%) were approximately equally influenced by the experience of other students that had previously studied in the UK.

The influence of agents, whose role is to recruit students for British universities, was nil for the parents, and very low (11%) for the students.

3.2 Perceived Benefits

The benefits, as perceived by the students and by their parents, are mainly similar. The most popular potential benefits are to improve the spoken and written English, to continue onto postgraduate study in the UK, and to achieve a high salary in China.
Results of the benefits of study in the UK from the view of students and of their parents are shown in Table 1.

An option given only to parents was “To impress friends and family”, only agreed by a limited number (12%). One comment added by a parent identified the benefit of “a safe living/studying environment and high quality the education”, also potentially a “better future”.

It was interesting, even with such a small sample, to consider the different perception of the advantages as seen by the parents compared with that of their children. Those especially related to working outside China, improving spoken English, obtaining a degree from a UK university and developing a potential network of contacts. Possibly the parents had a more long-term view than their children of these advantages.

Table 1: Benefits of Study in the UK

	Student as %	Parent as %
Potentially better employment in China	22	25
Ability to work in the capital	11	25
Opportunities to work outside China	-	37
Higher salary in China	33	50
Better opportunities to start their own businesses	22	-
To please my family or my child	11	12
To improve spoken English	44	100
To improve written English	56	75
To develop new friends in the UK	33	75
To develop a potential network of contacts	11	50
To obtain a degree from a British university	22	62
To continue with a postgraduate study in the UK	56	37
To continue with postgraduate study in another Western country	-	12
To continue with postgraduate study in China	11	-

Considering the preference of studying their current course to obtain the same degree from Southampton Solent University, but undertaken in China rather than at Southampton, there were some major differences, as shown in table 2.

It was clear from table 1. that one of the main benefits in studying the same course for the university degree in the UK might be in gaining confidence to speak and understand spoken English as well as understanding the British culture.

Table 2: Undertaking the British degree in China or in the UK

	Student as %	Parent as %
Prefer to have studied the current course for the Southampton Solent University degree in the UK	43	12
Not sure	28	87
Prefer to have studied the current course for the Southampton Solent University degree in China	28	-

The possible problems from the parents' perspective were related to gaining these skills, in addition to the cost of studying abroad and missing family and friends. When asked to consider that the main problems with studying in the UK, again there are some different views between these students and their parents, as shown in Table 3.

Table 3: Problems with Studying in the UK

	Student as %	Parent as %
Weather	22	-
Language	33	75
Cultural	33	62
Food	56	37
Different style of teaching	33	62
Different style of assessment	33	50
Missing family and friends	11	25
Accommodation	22	25

The main difference in the views was that parents perceived problems of language, culture and teaching styles as the major issues, whereas the students felt that food was the major potential problem.

When asked to consider if they would recommend studying in the UK for their degree, all but one of the students said yes (86 %) and all but one of the parents agreed (87 %).Further explanation from a parent was the disadvantages of "the high studying fee and living fee", whereas another parent identified the advantages that the British university has different "study situations than in China - so learn more new things to broaden horizons". Another parent said that "Firstly my children have the idea of going abroad for study and I think that as long as it is good for my child… I will actively support her and give her a chance".

Table 4: Enjoyed the Stay in the UK

	Strongly agreed as a %	Agreed as %	Disagreed as %	Strongly agreed as %
I have enjoyed my stay in the UK	28	57	14	-
My child has enjoyed his/her stay in the UK	25	75	-	-

The statement about enjoying the stay in the UK, in table 4, was felt to be true by the all but one student and 100% of the parents. It is to be noted that the stay to the date of the survey was only approximately four months of the course. This could influence the replies, as the students were still on a steep learning curve, relating to the use of English and the different way of studying. The only student with negative views expanded the answer with "in the UK, we must study hard, but I don't have any time to relax, so it is easy to make me tired". One parent said that they "had a worry about the safety in the UK". Another parent stated that “I have never been able to accept the child to leave myself, her mother always wanted to send her abroad, and later the child grew up, and asked more than once also the proposal to go (abroad) to learn”..”It's important for children to be independent, let her learn how to survive and not rely on her parents”. But “As time passed, I got used to it, and I think the child is (doing) really good”. One parent indicated that "we pay a lot and my child sacrifices a lot, spending a lot of time studying English, - we think she has really enjoyed her course in the UK". Another parent said that "through communication with my child, indeed, the teaching and control in China and the UK are different. The child started with a little confusion, and the pressure was great. After that, although the courses were different, (the students) exchanged their ideas and thoughts”.

The statement "a degree from a UK university is regarded highly in China" was agreed (86%) by all but one of the students, and agreed by (75%) of the parents, while only (25%). disagreed with this statement. One parent added that "we send our child to UK, not just for a degree, but other important things… we hope that our children can learn more different things, increase their knowledge and make the world better".

3.3 Views from a Focus Group on Student Issues

A focus group was undertaken with some of these students, to identify in more detail the issues associated with food, whether this related to the availability of purchase of ingredients for Chinese cooking, of the facilities in their accommodation to cook in the Chinese style, or at the menus within the university catering facilities.

The outcome was that rather unexpected. The Chinese students were very content with the cooking facilities provided in the students' accommodation and also found some of the food in the various university canteens suitable, especially the mushroom pies with broccoli as regular choices.

The students were not too impressed by the ready-made meals of "Chinese" microwave dishes or those served in many of the local Chinese restaurants. The main problems resulted in the difficulty of obtaining really fresh (i e alive) fish and chickens so they could be assured of the freshness of them, prior to cooking. in particular, they missed the variety of fresh-water fish available in China but not in the UK. They were also concerned about the blood content of the English meat, as they prefer their meet to be less bloody.
Although they were able to obtain some Chinese vegetables, in certain rather more expensive supermarkets and specialist shops, which specialised in Chinese food, they found that the prices were rather high and the choices were limited.

4. Statistics about Students from China

There has been since 2000, a steady increase in the number of Chinese students coming to the UK, for example in 2013/2014 there were 87,895 Chinese students whereas in 2015/2016 this had risen to 91,215 students. The UK Higher Education Statistics Agency reports that in 2015/2016 this out-numbered overseas students from any other EU or non-EU country [7]. The top 10 choices in 2015/16 for non-EU students are Business & administrative studies, Engineering and technology, Law, Architecture, building and planning, Mass communications & documentation, Mathematical sciences, Computer science, Social studies, Languages and Creative arts and design [8].

The University of Warwick undertook a survey on the destinations of over three thousand Chinese undergraduate and postgraduate students that had been studying at twenty two UK universities in 2013/2014, which indicated that 70% of these students planned to return to China on completion of their courses. A smaller survey of the eighty thousand Chinese students studying in the UK was also undertaken by the University of Warwick in 2016, indicated that students studying STEM subjects were more likely to wish to remain in the UK than those studying other subjects [9].

According to the Ministry of Education of the P.R.China., there has been in steady increase in the number of students studying abroard and returning at the end of their studies in 2016, there are 20,800 more students studying abroad which contributes to a 3.97% increase in comparison to 2015.This is a 36.6% increase, 144,900 more students,

compared to 2012. Between 1978 and 2016 there have been more than 4,566, 000 Chinese students studied abroad, of which 1,362,000 students are still studying abroad, 3,224,000 have completed their courses and 2,651,000 graduates have returned to China. The average course completion rate is 82.23% [10].

The Ministry of Education of the People's Republic of China, reported that nearly 500,000 people studied abroad at their own expense in 2016, which was approximately 91.49% of the total number of people studying outside China [10]. More than 90% of all these students studied in the US, UK, Australia and eight other countries, of which 77.91% were in English speaking countries. The proportion of those taking undergraduate and postgraduate courses is 35.51% and 35.51% respectively.

For those who were sponsored by the Chinese Ministry of Education, 36.54% studied science and engineering courses, 15.47% science, 6.68% medicine, 3.17% agriculture and 38.14% humanities. With an increasing number of students studying abroad, the return rate has also increased over the past decade. According to the Chinese Minister of Education Tao Xu, in the "Thousand Talented People Plan" there are many of the graduates from these non-Chinese courses, that become very successful entrepreneurs in China [11].

5. Conclusion

Studying abroad has now become a dream as well as a trend for the younger generation of Chinese people to gain more life and industry experience, more solid foundation, wider networking opportunities and better job prospects. The UK has an excellent reputation in education and has been educating and nurturing the next generation of professionals in all areas and in particular in STEM subjects. UK is a more culturally diverse educational environment in which students and parents would prefer to experience. For those who would prefer to stay in their home country to study, with a growing number of UK universities having overseas campus, more and more students will be able to receive a UK education. This not only helps the UK to grow in all STEM related industries but also puts the UK at the core of education in these subjects globally. In the long run, the economy in these countries should improve and the relationship between the UK and China will become closer as will that with other participating countries [11,12].

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Using Data Visualisation to Analyse Students' Academic Performance

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Abstract

This paper describes a dashboard software tool for the analysis of students' academic performance. This tool mainly focuses on lecturers and students in a university environment, and it aims to analyse students' grades from multiple perspectives, by providing users with multiple interactions.
The paper is divided into five sections: a) the review of existing literature on software tools used in academia for the performance measurement; b) the identification of the users' requirements based on interviews with lecturers and students, c) the functional and interface design prototype; d) the presentation of the dashboard software implementation and testing. The paper concludes by summarising its contribution and indications of further work.

Keywords: Academic Performance, Data Visualisation, Dashboard Software

1.0 Introduction

Spreadsheets are the most common computer software tools often used to analyse and present students' academic performance. Based on a study for this work, lecturers find it is an inconvenient and time-consuming process where it is hard to filter the information that they are interested, and to compare two different modules. Students often get lost in large electronic transcripts, where they cannot compare their performance between different modules and grade years. Moreover, although every module has a specific and clear course description stating the proportion of

each composition of the final score, they have no access to detailed data analysis for the students' performance for each assessment.

An advanced dashboard software tool has been developed where users can analyse grades from multiple perspectives. Only in this way, lecturers and students can understand deeper their performance, beyond the final score, thus make improvements accordingly. Different types of graphs and colours are used to give users an intuitive impression and the developers replace complicated charts with simpler graphs. The highly interactive function is an advantage over Excel, which makes this software flexible.

2.0 Theoretical Foundation

Dashboards are interactive, allowing an executive to drill into aspects of the display or switch between facets or views of the data [1]. Key performance indicators need special consideration because they are high-level measurements of how well an organisation is doing in achieving critical success factors – in other words, the goals or targets set by an organisation in their strategic plan [2]. Dashboards are composed of data visualisation tools like charts, grids, gauges and maps [3]. Although this work is not aimed to develop a dashboard for business purpose like market analysis and strategy prediction [4], the dashboard for students' academic performance undertakes similar roles, with these charts, grids, gauges and maps, where teachers can easily a) take advantage of a balanced scorecard approach to management; b) measure and understand an organisation's or individual's key academic performance indicators, like homework completion situation.

By reviewing the literature, the authors had the opportunity to identify the strengths and weaknesses, to understand what dashboard features can be used, and to evaluate their use in academia. In this section, the authors present a summary of dashboards used for academic purpose:

1) HCC (Houston Community College) developed a dashboard on its home page to show their enrollment, completion and transfer situation according to different types of students divided by gender, ethnicity, regions, etc. [5].
2) The State University of New York (SUNY) is committed to present a set of measures that demonstrate school's progress on English and Maths. It uses a measure called growth score, through computing with many aspects of students' performance, providing a result that comprehensively reflect the students' performance. Specifically, it uses plots with different colours to represents students at different performance levels, by comparing the height of different plots it can get the level of one school over another. This method shows obvious shortcomings, that is, there are many factors that may affect outcomes like property proportions [6].

3) SUNY also uses a criterion called Effect Size, which takes property proportion into account to show whether school performance is better than expected. If the

value line is higher than a specific point, then it can be assumed that it is appropriate to add more tasks for students to accomplish [6].

4) As for online reading resources, dashboards can also be useful. Loughborough University created a system where teachers can upload their reading situation online as a reference for students to help them find which book is truly valuable and how much time should they spend on each book. The information is all displayed by Pie charts and graphs in dashboards, which is easier to read than large amount of data [7]. This gave the authors a hint that dashboards can not only used by teachers but also by students to check special information on electronic panels, which may be easier and more efficient than books.

5) Nottingham Trent University uses a student's dashboard to help students interact with their engagement. The Student Dashboard enables students to take more control of their studies. Students can view their current engagement level and how they can proactively change it. Their tutor can also view their dashboard and they may use the information in the Dashboard as part of any discussions they have with students themselves [8]. The Dashboard currently calculates students' engagement using the following measures: library use, NOW logins, coursework submissions through Dropbox, campus swipes.

3.0 Requirements Analysis

3.1 Method

This work was guided by the above literature review but mainly by interviews with both lectures and students. Interviews helped to identify the users' requirements, based on which the functional interface was designed, and the dashboard was implemented.

Each interview lasted for 10 to 15 minutes where the developers discussed with lecturers and students issues such as a) the factors which influenced the students' academic performance, b) the contribution of dashboard software in the academic area, c) the data required to be analysed by the proposed dashboard, d) the functions required for analysis of students' academic performance from multiple perspectives, e) a design drawing showing basic functions, to show them how it works.

3.2 Users' Requirements

For lecturers' page, the requirements are:

a) The dashboard should provide for the lectures a quick view of students' grade, including average marks, trend of grades, and factors that influence grades, which should be presented in different colours;

b) It should also allow them to view the details easily, by adding some interaction to make the operation easier, for example, by clicking the student's name, users can get access to another dataset containing this student's details;
c) As a lecturer, users want to get responsive results from students' academic performance, to better improve teaching strategy, so this dashboard should contain a macrocomparison with students of the previous year;
d) Based on interviews, lecturers want to get a record on the attendance situation of every class. Also, the time range should be flexible and changeable.

For students' page, the requirements are:

a) This dashboard should help students manage and analyse their homework and attendance performance;
b) This dashboard should provide analysis of the grades. For example, make students be aware of their grades level, so they can make corresponding improvements;
c) Based on the interviews, it is known that students pay much attention on their homework situation, so dashboard should contain a part helping them analyse their performance on homework, like showing which section they are not doing well, so they can pay more attention to them.

In conclusion, in the students' page, the dashboard should help students manage and analyse their homework and attendance performance, as well as analysis of the grades. For the lecturers' page, the dashboard should give them a quick view of students' grade, make them view details easily, as well as a comparison with students of previous year.

4.0 Interface Design

Based on the above user requirements, aninterface prototype of the dashboard was designed, divided into *lecturer page* and *student page*, which each page having a different data view and functions.

For the *lecturer page* (see figure (1) below), users a) get a quick view of all students included in the module, b) select a students' name to get more details, c) view top/bottom students' situation, whose details can be viewed too, d) view the attendance represented with a bubble chart in the right corner.

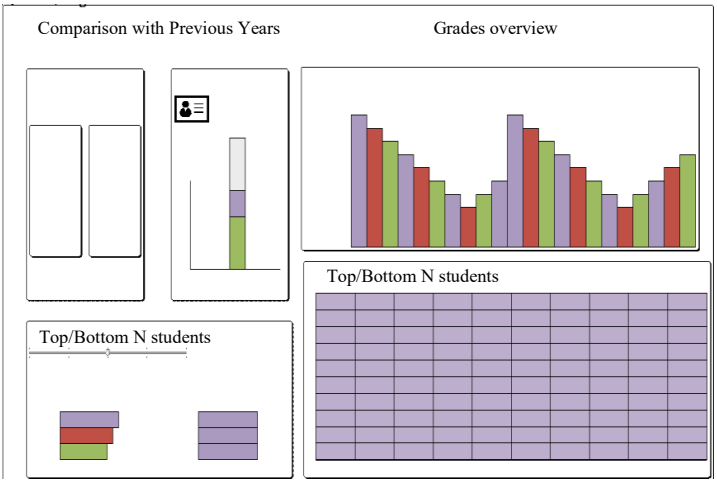

Figure 1 Lecturer Page Prototype

For a *student page*(see figure (2) below), user a) can view his/her grade for all subjects, b) can choose one to view the details of that subject, including every part of component of grades, such as homework, attendance and test. Besides, user can also get a polyline chart view of his homework, where he/she can easily know which part should be paid more attention, by dragging the slider.

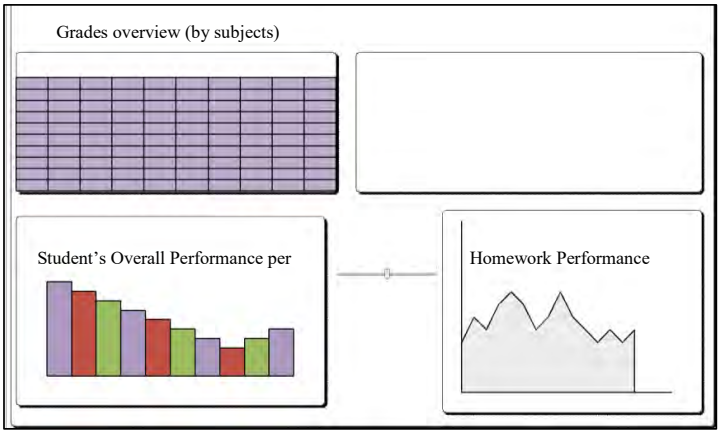

Figure 2 Student Page Prototype

5.0 Implementation and Testing

Like the prototype, the dashboard is divided into two parts, a) one for *Lecturer* user, and b) one for *Student* user. When a user enters user name/password, he/she can log into the system where all the relevant information is imported.

5.1 Lecturer Page

The lecturer page is divided into 5 main parts, see figure 3 below:

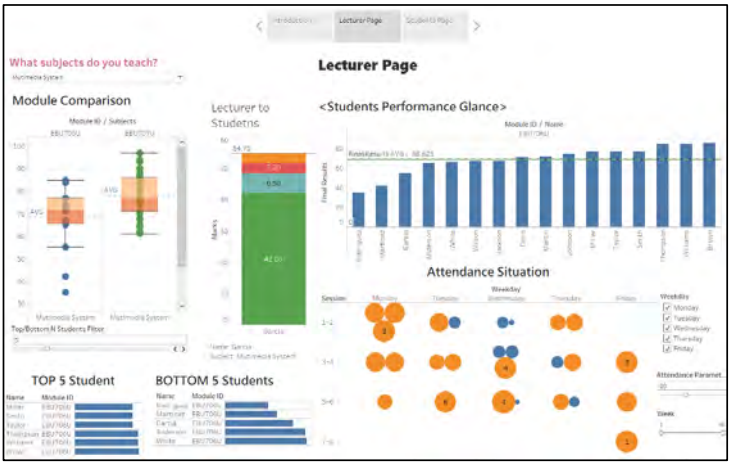

Figure 3 Lecturer Page

a) *The Module Comparison* part presents a comparison between the average overall mark of two modules; user can use a filter (*What subjects do you teach?*) namely to select a subject and to view the difference with another two modules.

b) *The Lecturers to Students* part presents a summary of the module's marks; either for the whole module or for a student -by clicking a student's name (e.g. Garcia) the detail of this student will be presented by showing four factors influencing the grades.

c) *Students' Performance Glance* part aims to help lecturers to analyse students' academic performance in a macro perspective, with average mark line highlighted.

d) *Top Students/Bottom Students* map provides a summary of the top/bottom students based on students' marks. The lecturer can set the range by dragging the slider (filter) and thus to find out who are the top/bottom students in the class.

e) *Attendance Situation* graph present a graphical view of students'attendance in the module's sessions, on weekly base, by each day; the criteria can be set by lecturers, which divide the data into two groups, representing by two colours.

5.2 Student Page

Student page is divided into 4 main parts, see figure (4) below:

Figure 4 Student Page

a) *E-transcript* part provides a detailed view of the assessments' marks for each module. All the subjects' titles are listed at the left side of the table, where student has the option by clicking the subject title to filter all dashboard's graphical visualisations, matching with the chosen subject.

b) *Homework* visualisationuse a line-chart to show a summary of the student's performance, namely the mark for each homework with the date; this helps student to monitor his/her performance in class activities over the semester.

c) *Target University Reference* sheet provides a summary of the entry mark range required by each university for further studies. This work mainly as reference source, facilitating students to set their mark goal for the undergraduate studies. If the user double clicks one box, user will get a quick glance ofthe Wikipedia page of the university. By analysing the relation between previous students' performance and their achievements, the dashboard gives users a better understanding of where they are, how far they get from their dream universities.

d) *The Students' Details* gives an intuitive impression of the grades compared to E-Transcripts; users can easily see how marks for each module will influence the final result (for example, Attendance and Homework). The modules are divided into a) those which students have completed all the assessments, b) those that students have not completed yet.

For those modules, see figure 5 below, which have not been completed, students can set a goal for final results, namely the function can calculate the expected assessment mark and show it on the label.

For example, in case of Cloud Computing module (where the student has not taken the exam), the student can simply drag the slider and choose a goal for expected final mark, and to know how much he/she should get in the exam to meet his/her expectations.

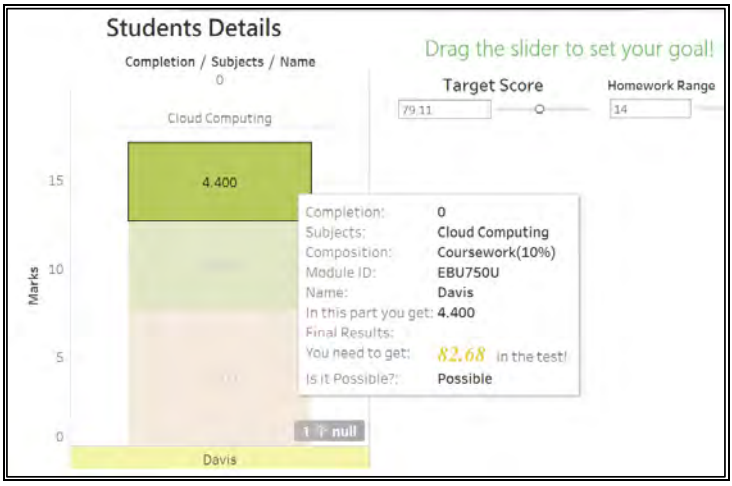

Figure 5: Target Score Function

As shown in this figure, the target score has been set to be approximately 79, to achieve this, the student should get more than 82 in the exam, which has been highlighted in yellow in the detail box. If student drags the slider the result will be changed accordingly.

5.3 Testing

Software testers used the user's point of view to find defects in the software through a variety of input and observation software outputs, without taking account of how a program is implemented. Lecturers and students that have participated in the interviews were asked to do part of the testing, having the opportunity to compare their requirements with the outcome, and give a feedback. Testers used a template data set, and used the functions one by one, in order evaluate the quality of the software.

6.0 Conclusions and Further Work

Most users stated that the main requirements have been implemented successfully, including some novel and useful design features. Overall, the functions are reliable, like stratified filtration. Users can find the specific students or subject they want. The most popular function is *Target University* reference, where students have access to the data that they are interested, but also presents in an intuitive way, which saves time.

In future, authors aim to improve the functionality of the dashboard, improving some of the existing functions and adding new features. Currently, the dashboard's data visualisations are based on theanalysis of the proportions for four factors (homework, coursework, attendance and test); these are fixed in existing dashboard, and thus they cannot be modified by the user. In a future version, users will have the option to add/modify/delete these variables, and to adjust them according to each module.

Currently in China, some universities use similar software to analyse students' academic performance [9]. This work can be the basis for the development of complete and efficient dashboard where it can be used and compare the students' academic performance among a larger range of universities.

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