

Blended Learning in Practice

Autumn 2017

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Editorial

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Welcome to the new look autumn 2017 edition of our e-journal Blended Learning in Practice. In this edition we have five research articles from participants on the Post Graduate Certificate in Learning and Teaching in Higher Education (PGCertHE) programme. In our staff voice section we are pleased to publish an article from lead author Daniel McCLuskey and colleagues in the Micro Electro-Mechanical Systems (MEMS) Group at the university.



Dominic Bygate



Rosemary Godbold discusses the use of ethical decision making software which

Within this edition:

adopts an alternative, values based approach to deliver ethics education through student-centred learning. Drawing from student-centred theory, lecturer experience and data from students who have shared their experiences the potential of the software to facilitate deep learning, and critical and informative reflection is explored

Helen Barefoot

Nada Yousif reviews the rationale for using research informed teaching, focussing on instilling engineering students with industry ready skills.

Jeremy Clancy's article "Palaces or Prisons: How to Encourage Optimum Creative 'Flow' in a Small Group Context" attempts to synthesize research in creativity and innovation implementation in small groups and explores the interplay between group dynamics and creativity.

Sulanie Peramunagama discusses particular attributes of online examinations that can lead to cheating and outlines an alternative assessment method aligned with the pedagogical intention that may be used instead. One that reduces the motivation and opportunity to cheat.

Thom Cuschieri investigates the pedagogical aspects of the so-called *studio crit*, a central method for delivering formative feedback within the context of art and design.

Anouska Plaut explores the use of visual metaphor as a technique for facilitating staff development. The limitations of this technique are explored and a set of preliminary guidelines for best practice offered.

Daniel McCluskey and his co-authors outline the development of a research informed, undergraduate module that incorporates the principles of the Massachusetts Institute of Technology developed approach to engineering education where the core components of study are formed around the concept of CDIO (Conceive, Design, Implement, Operate).

Helen Barefoot and Dominic Bygate

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Dr. Rosemary Godbold is a senior lecturer and registered nurse in the School of Health and Social Work at the University of Hertfordshire. Her speciality areas are ethics and values based decision making in health care practice and much of her research has been with students, particularly focussed on ethics education for pre- and post registration health professionals and most recently, exploring how student nurses learn to care.



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Jeremy Clancy is a lecturer on the University of Hertfordshire's Animation Degree Programme where he teaches Cultural and Contextual Studies as well as Creative Writing and Ideation. His current research interests centre around how creative thinking can best be facilitated and encouraged in a learning environment. Outside of his university work Jeremy is also an award-winning filmmaker who runs his own media company.

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Dr. Nada Yousif is a Senior Lecturer in Biomedical Engineering. Nada's research interests are in neuro-stimulation and computational modelling of the human brain. She received her PhD on Dynamic Network Models of the Brain from Plymouth University in 2006 following which she worked on Deep Brain Stimulation and Motor Control as a postdoctoral researcher. Nada joined the University of Hertfordshire in 2016 to teach on the newly established Biomedical Engineering programme and her teaching interests centre on computer aided engineering.



Sulanie Peramunagama

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Sulanie Peramunagama has been working as an educational technologist at the Learning and Teaching Innovation Centre (LTIC) at the University of Hertfordshire since 2015. She graduated from the University of Hertfordshire with an MSc in e-learning Technology in the same year. Her main work at LTIC concerns online assessment. Prior to joining the University of Hertfordshire, Sulanie has worked in the software industry as a programmer and a quality assurance engineer. She has also lectured at the Sri Lanka Institute of Information Technology (SLIIT) where she taught programming and data structures. She has recently completed her postgraduate certificate in Learning and Teaching in Higher



Education and has been awarded a Fellowship of the Higher Education Academy. Her article for BLIP was influenced by her current research interests which are in online assessment and invigilation, reducing online academic fraud and mobile e-learning applications.

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Dr. Thom Cuschieri is a graphic artist and lecturer with a background in abstract mathematics. He is interested in concepts that lie at the intersection of art, mathematics and literature, especially Borgesian notions of the infinite and the impossible. He is currently working on two projects: a study of early cyberspace usage and the figure of the *cyberflâneur*, and an illustrated version of Mervyn Peake's *Titus Groan* informed by the work of the American artist and illustrator Edward Gorey. He leads the second year cohort on the Illustration BA at the University of Hertfordshire and is a Visiting Lecturer on the University

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Anouska Plaut has just taken up a new role in the Hertfordshire Business School as a Visiting Lecturer and Learning Agreement Programme Lead. At the time of writing this paper for BLiP and from 2014, she worked as a Development Facilitator for the University, organising and facilitating staff development including skills-based and reflective workshops, corporate induction and managing the Graduate Employment Scheme. Anouska began her career as a broadcast journalist and prior to joining the university she worked in several communicationsbased and teaching roles



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Dr. Daniel McCluskey is Director of the Centre for Research in Biodetection Technologies (CRBT) and Chief Engineer of the University of Hertfordshire's (UH) Microfluidics & Microengineering Research Group (MMRG). He graduated with a BEng(Hons) Aerospace Engineering in 2003 from UH before gaining his PhD from Coventry University in 2009, concerned with Computational Fluid Dynamics analysis of hydrocyclones. He focuses on the rapid development of turn-key, fluid dynamics based, integrated biodetection systems. Leading a prototype development team within the MMRG. In 2011 Daniel led the development of a Level 6 module

for the School of Engineering & Technology with the aim of incorporating research outputs from the MMRG in a taught programme. Through the support of the LTI this module was developed from the ground up, incorporating several developing approaches to pedagogy from the outset.

Is the use of the values exchange web based decision making software for teaching ethics to future health professionals an example of student-centred learning?

Rosemary Godbold

Abstract

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Ethics education is now accepted as an important and integral part of programmes that lead to student's registration as health professionals. Despite this, there is wide variation in philosophical and pedagogical approaches, resulting in mixed experiences for students who may be alienated by traditional methods and left unable to see the practical real world applicability of ethics to their future clinical practice. This paper examines the use of an alternative, values based approach using ethical decision making software (the Values Exchange) to achieve a student-centred learning approach to ethics education. Drawing from student-centred theory, lecturer experience and data from students who have shared their experiences of using the Values Exchange, the potential of the software to facilitate deep learning, and critical and informative reflection resulting in confident decision makers who can apply their learning to future practice is explored.

5 key words: Student centred-learning, ethics, education, health professionals, values.

Introduction

This paper considers whether the use of web-based, decision making software to provide ethics education for both pre-and post-registration health professionals is an example of student-centred learning. Beginning with a background about the provision of ethics education for health professionals, this paper then explains the theoretical foundations of the Values Exchange and the process of ethical deliberation which it facilitates. Building on previous research which has confirmed the potential of the Values Exchange to facilitate student learning, this paper then considers whether embedding it's use in both undergraduate and postgraduate programmes constitutes an example of student-centred learning. This is achieved by applying theoretical perspectives of student-centred learning and drawing on data gathered from undergraduate students about their experiences of using the Values Exchange.

Background and challenges of teaching ethics

Ethics is now accepted as an important and integral part of the training of health professionals internationally. This has followed a catalogue of seminal events which demonstrate the terrible consequences for patients which can result from ethically poor practices. Most recently in the UK, the Francis Report into multiple failings in the delivery of care at Mid-Staffordshire NHS Trust ultimately concluded that the Trust prioritised its finances over its quality of care, failing to put patients at the centre of its work (Francis, 2013). Rising in tandem are consumer expectations, increasingly complex health care environments, an ageing population and growing awareness of the actual and potential dangers of health care (Soop et al, 2009; Wilson et al, 1995). So how are educators to produce a health work force which consistently delivers high quality, morally acceptable care underpinned and guided by established core values?

Despite a pressing need and a clear commitment to ethics education, approaches vary widely and there is little consensus on its optimal delivery (Woods, 2005). Following a literature review on medical ethics education, Eckles et al (2005) concluded that two main views exist as to its purpose; it should be a means of creating a virtuous doctor or that it should equip doctors with a skill set for analysing and resolving ethical dilemmas. This reflects the divide between virtue ethics, which focuses on the character and actions of the person, and theoretical approaches, such as utilitarianism and deontology, which focus on action and provide frameworks for working through and resolving ethical dilemmas. Following an evaluation of ethics in nursing education, Vanlaere and Gastmans (2007) argue for a combined approach which uses virtue ethics to cultivate a caring attitude, a 'right-action approach' which requires nurses to 'conform to a number of minimum principles' and incorporates the use of codes of ethics and critical reflection. Another key challenge for educators is whether to opt for on an outcome based approach, which assumes that it is possible to reach a 'correct' answer to ethical dilemmas, or instead to give primacy to process. This choice rests on philosophical differences about what ethics is and whether objectively 'right' responses are possible, or whether it is the process of ethical deliberation which takes account of the subjective, value driven nature of ethical deliberation which is important.

Given the plethora of approaches, a lack of agreement amongst educators and no clear evidence as to which is the most effective, it is not surprising that ethics education is seen as difficult to both teach and assess (Bertolami, 2004; Campbell et al., 2007; Singer et al, 2001; Wong & Chung, 2003). The student experience of ethics education is mixed. Many students view ethics education as boring (Parsons et al, 2001), using alienating theoretical jargon (Cowley, 2005; Hattab, 2004) and lacking applicability to real life (van der Burg & van de Poel, 2005). How we teach ethics is as important as what we teach (Paterson, 2010, cited Malpas, 2011). The challenge for educators is to deliver successful ethics education in courses which are often cross-disciplinary in ways that are engaging and have meaning and applicability for students in real life situations that they are, or will be, working in.

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The Values Exchange

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The Values Exchange (VX) is web based, decision making software developed by Seedhouse (2005, 2009), underpinned by the basic premise that all decisions in health care have an ethical component and are a balance of both evidence and values. Its primary goals are values transparency and democratic decision making (Seedhouse, 2005) and it is used in a wide variety of educational contexts internationally. Using a series of 'think screens' the user is first asked to consider a case study (see Figure 1) and then to provide an immediate response indicating whether they agree or not to a proposal relating to the case.



Figure 1 The VX case proposal

The student then proceeds to the reactions screen in which they are asked to build a pie chart which represents how they feel by choosing from a range of pre-set principles and to explain their choices and expand their thinking with associated questions and free text boxes. Those familiar with Seedhouse's earlier work will recognise the evolution of the Reactions screen (Figure 2) from the Rings of Uncertainty and the Reasons screen from the ethical grid (see Figure 3).



Figure 2 The Reactions Screen

Once students have completed their analysis of the case using the reactions screen, they then proceed to the reasons screen (Figure 3) which requires them to choose from a series of tiles to

construct an argument in response to the case. Again, the users are provided with prompts which ask them to further explain and justify their thinking and free text boxes for them to add any additional points to build and clarify their arguments.



Figure 3. The ethical grid.

Students then submit their analysis. The Values Exchange automatically generates a report which summarises their responses. Once they have completed and submitted their response, the students can then see their own and others' reports which show how their peers have responded to the case. The author has delivered ethics education for a variety of health professionals (including nurses, midwives, physiotherapists, occupational therapists, paramedics and podiatrists) in both undergraduate and postgraduate programmes for over eleven years. Using a values-based approach which recognises and emphasises the intrinsic and necessary role of values in decision making, the focus of learning is on the process of decision making. To bring the subject alive for students and to provide some real-life applicability students are asked to bring challenging decision making scenarios from their practice and post them as cases on the Values Exchange. They are then asked to complete their own and at least 2 other cases from their colleagues and reflect on their learning both from deliberating the cases using the Values Exchange and from looking at the reports of others who have completed analyses of the same cases.

Previous research with postgraduate health professional students suggests that the Values Exchange offers an engaging way to recognise the role that values play in decision making, encourages thoughtful student reflection, assists students to understand the complexity of decision making and broadens student perspectives and awareness of values diversity (Lees & Godbold, 2013; Robb et al, 2012). Recently, data was collected in a small-scale study with undergraduate health professional students enrolled in a large inter-disciplinary ethics module. Ethics approval for collection of the data was received from the University's ethics committee and fourteen students consented to researchers accessing their responses to the following questions about their experiences of using the values exchange:

- Was your thinking challenged by the Values Exchange process? If so, in what ways?
- To what extent did reading your own VX reports as well as the reports of others trigger new thinking about the case scenarios? Please explain.
- Did the reports of others contribute to your understanding of how decision making differs between individuals? If so, please explain.
- Through using the VX have you gained any insight into the specific values affecting your decision making? If so, please explain.
- Please reflect on what you see as the pros and cons of the VX decision making framework.

Using a qualitative descriptive approach, the data was thematically analysed by two researchers independently (the author and a colleague; see Godbold & Lees, 2014) using Braun and Clarke's 6 step process (Braun & Clark, 2006; Clarke & Braun, 2013). Having combined the findings, re-analysis of the data took place and agreement reached on the emergence of four key themes:

1. Uncovering /revelations

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- 2. New understandings of self and others
- 3. Freedom to think /learn
- 4. Application of their learning from the VX experience to future professional practice.

Godbold & Lees, 2014

With on-going ethics approval, the responses collected from the students were re-examined by the author for evidence of student centre-learning using the six fundamental tenets of student-centred learning identified by Lea et al (2003) as a framework. Drawing from theoretical perspectives, teaching experiences and re-analysis of the student's experiences, the following argues that the use of the Values Exchange is an example of student-centred learning.

Student centred learning

Student centred learning has been identified by the European Students Union as a method of learning or teaching that 'puts the learner at the centre' requiring a shift in focus from academic teaching staff to the learner (Boyer, 1990, cited Attard et al, 2010, p. 6). Emerging out of constructivist learning theory in which learners make sense of and 'seek to build coherent and organised knowledge' (Mayer, 2004, cited Baeten et al, 2010, p. 245) student centred approaches emphasise student responsibility and activity in learning with the aim of achieving deep learning and understanding (Baeten et al, 2010, p.245). It can increase student engagement, particularly in diverse student populations (Gerstman et al, 2012) and significantly improve students' perceptions of the quality of teaching and learning environments (Kember, 2009). Its use in Higher Education is increasing due to a necessity for students to have communication, teamwork and self-assessment skills and to be able to independently acquire new information, be critical thinkers, problem-solvers and lifelong learners – all aspects of learning unsupported by traditional, didactic lecturer driven approaches (Plush & Kerwald, 2014).

As O'Neill & McMahon (2005) observe, learning is often seen as either student-centred or teachercentred, but the reality is not so clear cut. They propose that these terms are best conceptualised along a continuum with teacher-centred at one end and student-centred at the other, with the removal of contextual barriers facilitating the move further along the continuum towards learnercentred education (Table 1).

Teacher-centred Learning	Student–centred Learning
Low level of student choice	High level of student choice
Student passive	Student active
Power is primarily with teacher	Power primarily with the student

Table. 1: Student–centred and teacher–centred continuum: O'Neill & McMahon (2005).

Although the completion of the learning task using the Values Exchanges is given to the students by the lecturer, within that exercise the students have choices about which cases they do. They are also given a minimum number of cases to complete, but they can complete as many cases beyond that as they choose. As long as the case scenario they choose to post on the Values Exchange has relevance for their current or future practice, the students have total choice about what issue they wish to post. By necessity, there is a set time within which they can complete the cases, but because the Values Exchange is web based, completion of the cases is only restricted to when and where students have the technology and internet access.

1. Reliance on active rather than passive learning.

Using the Values Exchange is an active learning exercise. Students are required to actively engage with the contents of the case scenarios and apply their thinking within the frameworks provided by the 'think screens'. For example, one student said that 'I learned that there is no absolute "good and right" decision. And the "good and right" decision is contextual and depends on each case.' This is an approach promoted in class, but the student had come to this understanding through his own active learning facilitated by the VX. Likewise, other students reached their own understanding about the process and context of ethical deliberation:

'The process made me realise there are no simple answers to ethical dilemmas and it takes time to work out the most appropriate solution.'

During completion of cases, the VX requires students to actively prioritise their own values in relation to any given scenario. To achieve this, student reflection is required to understand their values base and how these influence their decision making:

'I have gained the knowledge that my personal values play a big part in my decision-making. The most specific values I have placed emphasis on most [sic] is trust, respect and practising empathy.' 11

'I did find it interesting that 'good friends' has some very opposing views to mine. As prior to this paper, I just took it for granted that we shared the same opinions on most things'.

'I am a mother – this colours many of my decisions as I [sic] taken on a maternal role. I have a strongly spiritually oriented values base, this also influences my decisions'

Not only do these examples demonstrate active learning, but also an autonomous arrival at selfawareness and insight which is in keeping with both a student-centred approach and the goals of values based ethics education.

2. AN EMPHASIS ON DEEP LEARNING AND UNDERSTANDING.

Deep learning is represented by a move from students as passive recipients of knowledge to a deep level of understanding and 'functioning knowledge' in which the learner puts their knowledge to work and then uses it to inform their professional decisions (Biggs & Tang, 2011). Further, focussed research is required to assess the impact the students' learning through using the Values Exchange has had on their professional practice, but the students recognised specific learning as important for their future practice.

'The VX helped me to see the case as a health professional whose duty is to help people in need; regardless of their background, in fair and lawful ways.... I have gained insight about my duty regarding equity for everyone especially for minority groups.'

'I realise I have conflicting values at times – the Western right wing approach "look after yourself first" and "user pays" which I was brought up with and the "help those who need it most" philosophy necessary for my role as a health practitioner'

Two of the students identified the inter-disciplinary learning they had gained as crucial for their future roles and health professionals:

'I think it is positively crucial for me to be aware of how people from different fields of health see the scenarios, as I WILL be likely to work with other professionals from different disciplines in future time. It is significant to understand the way they think, in order to work in an effective and collaborative manner.'

'This made me think further about how the case would have different outcomes if handled by different professions in real life practice and hence the need for different professions to work together to address the various aspects of a patient's needs'.

Others identified more general examples of deep learning about themselves:

'Made me dig deep and think about my opinions and what I deem to be important.'

'The VX... has brought to my attention how much I think on an emotional level and how I consider people's rights to be important... admittedly I had not really thought about this before'.

3. INCREASED RESPONSIBILITY AND ACCOUNTABILITY ON THE PART OF THE STUDENT.

It was not so much the responsibility and accountability for their learning which came through in the student's experiences but perhaps, more importantly, a sense of responsibility and accountability for the decisions they will be making in their future clinical practice.

'The cases also make you put your thinking to use in possible real situations. When I am a health professional my decisions will make a difference and affect people's lives and I feel I can live with my future choices'.

'My decision making prior to using the Values Exchange primarily focussed on the practitioner's role and perspective and now after the Values Exchange I have developed to also consider the perspective of others that are involved in the case before I make an ethical decision.'

Following a literature review of 118 research articles Baeten et al found that a number of factors impact on the efficacy of a student-centred approach, including learning environments which establish autonomous motivation and success, students who feel self-confident and teaching methods that are interactive, support understanding and facilitate learning (2010, p. 253). These features are evident throughout the data, but some students specifically identified the impact their experiences had on their self-confidence:

'I often got confused about an initial decision as I thought deeper. This led me to change my choice many times for one case. However, as I got more thoughts and reasons for that, I was getting convinced about my decision and myself..... One of the reasons I like the VX the most is it allows me to see the conflicts and allows me to interpret neutrally.'

'This process was a great opportunity for me to think in a systematic way regarding a case, to provide more validity and certainty of my decisions.'

4. AN INTERDEPENDENCE BETWEEN THE TEACHER AND LEARNER.

The student themselves and their peers become the primary source for learning and the VX is the vehicle which facilitates that. The lecturer becomes an advisor, guiding students on any technical aspects, such as login issues or setting up the cases. An important part of the lecturer's role is to teach the fundamental ideology that there is no right or wrong response to any of the VX cases, instead, it is the process and thoroughness of their deliberations which is important. Students are also aware that the underpinning philosophy of the VX promotes an environment where no one perspective is privileged and all voices are equal. Commonly the lecturer will complete the cases that the students have posted which promotes this democratic philosophy.

This input is clearly important, with one student observing that the VX represented 'A welcoming environment to air your views without fear of any negative outcomes.' Another noted, in contrast with alienating jargonistic theoretical approaches, that 'The VX cuts through the ethical jargon and it gave me the confidence and opportunity to compare my views with others in a safe environment.'

5. MUTUAL RESPECT WITHIN THE LEARNER-TEACHER RELATIONSHIP.

When Lea et al (2003) asked students about their experiences of student-centred learning, their participants saw 'conventional didactic models of teaching to be less motivating and less effective than more student-centred approaches'(Lea et al, 2003, p.331). However, they expressed anxiety 'about an approach that lacked structure, guidance and support in the name of being student-centred' and did not want to be left alone to learn for themselves (p.331). Even though students are provided with foundational ethical and values-based theory, an on-site computer lab workshop and constant open availability of the lecturer, negative experiences are a reminder that students require ongoing, active support and guidance:

'VX offers a great variety of options and gives us the freedom to interpret and justify our values..... At the same time, freedom can be very overwhelming. I felt the pressure of choosing between all those options and sometimes I felt the need for a little guidance'.

'The software itself takes a bit of time to learn and get used to though – this may be difficult for people who are not good at computers. Some people may be slow typers so it takes them extra time to complete the cases... '

Likewise, while the flexibility, format and democratic philosophy of the VX appeals to many students, it is important for the lecturer to remain responsive to those students for whom the VX does not fit with their learning style:

'The VX doesn't fit with my own style of deliberation and I lost the flow of thought. I can generally explain myself when the need arrived and I was constantly frustrated looking for a way to explain myself.' 'I would have preferred to cross into discussion / debate in week 11 rather than more online VX work, maybe break into smaller groups'.

Perhaps an ongoing feedback loop to the lecturer would allow students to communicate their experiences during the module so that alternative teaching experiences could be provided.

6. A REFLEXIVE APPROACH TO THE LEARNING AND TEACHING PROCESS.

"Transformative learning involves a particular function of reflection: reassessing the presuppositions on which our beliefs are based and acting on insights derived from the transformed meaning perspective that results from such reassessments." Mezirow, 1990

Throughout this analysis, there have been many examples of the reflective learning described by Mezirow where students have gained insights into their own and others values base, their assumptions about decision making and the values driven reality of ethical deliberation. Perhaps the most significant is represented by the learning the students describe from their peers. Once the students have completed and submitted their thinking about a case, the VX then transforms their responses into a report which both the student and others who have also completed the case can view. Their reflection on this part of the process provides powerful examples of how the VX can facilitate transformative reflective learning and, in some instances, tangible future benefits for their clinical practice and patients. 'Reading other people's viewpoints, I have developed an insight of how to be fair to my patients'

'Each and every person had a different way of thinking and reasoning which allowed me to critique my own thinking and reasoning'.

'Learning from other people's reports has really made me think about what other people might think... Reading their perspectives definitely gave me further understanding as to what led them to their decision and make comparisons to what I thought, which is good.'

'Reading the reports of others was an eye-opener for me. I was able to learn from others things that I otherwise did not mention or think of when deliberating the cases. I was able to see things from a different perceptive and respond the ways in which other people come to decisions and even critique on what could have been better decisions'.

'Reading my own and others' VX reports helps me see the big picture and gives me the chance of seeing different angles on the same case.'

'The VX challenged my thinking process to consider and address other aspects of the problem which I have not considered on my own.'

Summary / Conclusion

Ethics education is now an accepted and integral component for all students enrolled in education courses to become health professionals. However, approaches and underpinning philosophies vary widely and reported student experiences of traditional methods challenge educators to diversify and adapt their pedagogical approaches to enliven and engage them in ways which have practical application for their future clinical practice. The advantages of a student-centred approach for deep learning, fostering critical thinking skills and improving student's experiences are now well documented. While further, focussed research is required to substantiate these findings, this analysis suggests that with lecturer support, the VX does facilitate a student-centred learning approach with the potential to realise the goals of both a values-based approach to ethics education for health professionals and student-centred pedagogies.

ACKNOWLEDGEMENT

The author would like to acknowledge the role of Amanda Lees in collecting the data used in this paper.

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Palaces or prisons: how to encourage optimal Creative 'flow' in a small group context

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Abstract

Due to the heavy workload of producing their end-of-year 2D and 3D animation films, students on the University of Hertfordshire's Animation Degree will work in small groups of four or five to take their films from conception to completion. However, sometimes the creative talents of different individuals do not mesh well with others which can affect the overall quality of the project. In this article, I will use research and theory drawn from a predominantly social and psychological perspective to shed light on creativity and dynamics in small groups, and how factors such as group make-up, internal hierarchies and group interaction can help or hinder creative flow. I will also be discussing the work of Michael West, from his distinctions between creativity (idea generation) and innovation (implementation), to his observations of how these related stages of the creative process are affected by pressure outside the work group. This article will be of interest to any educator finding themselves perplexed by the interplay between group dynamics and creativity.

Introduction

The term "creative flow" is of relatively recent origin and relates to an "optimal state of consciousness where we feel our best and perform our best." (Kotler, S., 2014, p.2)

Western conceptions of creativity often place individual achievement and personal genius (Moore, 1997) above forms of creative practice that take place in a shared or grou, environment. However, despite the prevalence of such notions, it takes little effort to challenge these limited ideas of creativity, as a cursory look back into recent popular culture will demonstrate: "The Beatles, the discovery of the structure of DNA by Watson and Crick, or the collaboration among the French impressionists" (Bechtoldt, et al. 2012, p.838)) – examples of successful small group collaboration are numerous. However, despite the prevalence of the many examples, common understanding of how best to achieve an environment conducive to creativity in a small group setting is limited (ibid).

As a lecturer on the University of Hertfordshire's 2D and 3D Animation Degree Programme, I have keenly felt this lack of clarity, and have, over the last few years, struggled to find a solution to the problem of how best to encourage group creativity.

During Years 2 and 3 of the University of Hertfordshire's 2D and 3D animation programs, students are expected to create original 90-second short films that serve as a summary of all they have learned. This gives them the opportunity to demonstrate their imaginative vision, storytelling abilities, artistic skills and technical prowess. The films they make, and the quality of the creative ideas they are built around, are extremely important and often become the "calling cards" that can gain a student access to the competitive animation industry. However, because of the intense nature of animation production, individual students are not able to produce these films alone and at the start of Years 2 and 3, groups of three to five students are formed who will create these films together.

One of my key duties over the last few years, has been to oversee the formation of these small work teams, during which time I have personally witnessed hundreds of groups form, often with extremely surprising results. One common example is the way in which groups formed of some of our less able students can outperform their more talented peers when the interplay, group chemistry and creative "flow" has been right. This has led me to speculate on how, as an educator, I can best facilitate and encourage a similar environment of optimal creative 'flow' in all the small group formations I oversee.

To facilitate my thinking into these areas the main body of this essay will be dedicated to a review of key topics surrounding recent thinking into creativity in a group setting. These will be listed under three main headings: *Heterogeneity, Homogeneity and Hierarchy; Integrating Group Processes: Approaches to Creativity* and *External Influences on Creativity and Innovation*.

Another factor motivating my research into group creativity, is regarding a series of workshops (Creativity Workshops) I currently run over a 5-week period, in a quiet part of Semester A, during year one of the animation degree programme. These non-assessed workshops are presently run in an ad hoc manner yet could be much more effective if their integration was considered within the animation degree more holistically. In the discussion section of this essay, entitled 'Creating the Optimal Environment for Small Group Creativity' I will be reviewing my research findings to consider how I can best utilize the 'Creativity Workshops' to prepare students for their experiences in years two and three of the animation programme. Within this section, I will also be considering how my research findings can best be 'taught' or shared with the students in an educational setting, and will be drawing upon Kolb's notion of the Learning Cycle and his constructivist theories of student-centred learning, as tools to help me. This section will be of interest to anyone contemplating how best to attain the optimal conditions to facilitate creative flow in small group setting.

Research methodology

Research into creativity and groups is wide ranging, with keyword searches for 'creativity + group' yielding 1,990,000 results on Google Scholar, and over 298,000 recommendations on the University of Hertfordshire's online library. Most of the research papers listed under these searches were produced after the 1950s and fall into three main camps: work on personality, cognition and how to stimulate creativity (Craft, 2001). However, the data I found to be of most relevance to my investigation into group creativity comes from an area of recent research, that focuses less on the individual and more on creativity in its wider social context (Rhyammar and Brolin, 1999). This form

of research into creativity, which can be loosely defined as coming from a "social constructivist" perspective, popular in the 1980s and 1990s, looks at creativity from a "social psychological framework which recognises the important role of social structures in fostering individual creativity" (ibid, p.34).

Aside from these social constructivist studies, most of the other works cited in the analytical section of this paper come from research conducted in a business setting, which despite some superficial differences, have provided useful insight to the subject.

Heterogeneity, homogeneity and hierarchy

One factor impacting successful group structure is the concept of heterogeneity, with many studies showing how ideation and originality are enhanced when groups are formed of individuals from diverse 'heterogeneous' backgrounds. In their study of 100 healthcare teams, Borrill et al. (2000) found that the "greater the number of professional groups represented in the team, the higher the levels of innovation, and the higher the levels of radicalness, magnitude, and novelty of innovation in all domains of the team's activities" (Borrill, et al, 2000, p. 58). However, in contrast to this research finding, other studies found no real relationship between group diversity and creativity, even suggesting a negative relationship, postulating the idea that high levels of heterogeneity can adversely affect group dynamics by creating a climate where "individuals are apprehensive to share their creative ideas for fear of social inhibition" (Ancona and Caldwell, 1992, p.287). Diehl and Strobe (1987), with their research into group brainstorming, take this notion further, suggesting that creativity and group work are mutually exclusive, "individuals working alone, whose efforts are then aggregated [always] outperform group where individuals brainstorm together" (Diehl and Strobe, 1987. P. 370).

In contrast to heterogeneity, group 'homogeneity' refers to the notion of groups comprised of individuals from similar backgrounds and professional practices, with research suggesting that too much homogeneity in a group's makeup can lead to situations where "groups fall into groupthink, a state of lazy, shared consensus where no one wants to rock the boat" (Janis, 1972. p.68).

What is perhaps clearer than the ambiguities surrounding the concepts of heterogeneity and homogeneity, is the relationship between creativity and hierarchical structures. Research suggests, almost unanimously, that top-down power structures and creativity do not mix, or as Anderson et al. (2010) suggest, "steeper hierarchies will harm collective success when groups work on tasks that require a broad range of ideas and perspectives" (Anderson, et al. p.62). This idea was anticipated by the Russian social theorist and semiotician, Michael Bakhtin, and his contrary notions of 'polyphony' and 'monologism', with polyphony (borrowed from music) referring to the creative interplay of a multitude of voices, and monologism, a solitary authoritarian voice which dominates, and shuts down creative dialogue.

"Truth [creative truth] is not born nor is it to be found inside the head of an individual person, it is born between people collectively searching for truth, in the process of their dialogic interaction." (Bakhtin, 1993, p.128). This notion is reiterated by Keenly et al (1986) who state that "[shared] narratives can represent a useful alternative to the traditional positivist discourse: by introducing voices of others into a narrative, it prevents any of them from dominating the story and finalising its meanings" (Keenly and Oswick, 2004, p.140).

The sense of creativity as a shared dialogue, described above, also has the effect of fostering integration and commitment to the group (Bowers and Seashore, 1966), producing engagement in the project or "task orientation" (Emery, 1959). To some extent, this balances Diehl and Strobe's research finding that individuals are more creative when alone, and not in groups at all.

Integrating group processes: approaches to creativity

What becomes apparent from the above research is the many ways in which creative flow in groups influences, and is influenced by, the quality of the relationships and various interconnections between group members. The harmonious feeling of group cohesion is an important factor in successful group formation. This is not so difficult to understand if we consider that "the very essence of creativity is its novelty, and hence we have no standard by which to judge it" (Rogers, 1995, p. 351). Sharing challenging ideas can only take place in an environment of trust and intimacy where social insecurities are at a minimum. "Sharing ideas with others in a team can increase the chances of producing quite novel ideas, but this requires also that group members attend to one another's ideas" (Paulus, 2000). Paulus directly states that groups can only function when members actively listen to the input of others. Another factor that promotes cohesion and creativity is what Runco (2012, p.155) refers to as "unconditional positive regard", or the appreciation that during the ideation stage groups should avoid curtailing creative input by any form of criticism whatsoever.

A further element affecting creative flow is the notion that "teams are more likely to generate innovation when the group task design allows for a group process that is emergent, unpredictable, and improvisational" (Sawyer, 2007. p.235).

This point confirms the findings of William Gordon and his problem-solving methodology, developed in the 1960s, *Synectics*, (Figure 1) which called for group practitioners to move away from their "safekeeping self", a procedural state of being associated with 'getting things done', and instead encouraged creators to access their "experimental self", a playful aspect of everyone's psychological make-up that is highly speculative and driven to seek out new possibilities (Gordon, 1961). Another element that can have an adverse effect on creativity is what Kruglanski terms, 'cognitive closure', or the desire for individuals to seek a definite answer to a question rather than entertain states of uncertainty or ambiguity (Kruglanski, 1989). He goes on to argue how the impulse to seek closure to creative problems can curtail the ideation stage, shutting down creative possibilities.



Figure 1: Synectics: Intersection of Climate, Thinking & Action (Gordon, W.J. 1961)

External influences on creativity and innovation

The final research area I want to mention comes from Michael West's "Sparkling Fountains or Stagnant Ponds" (2002) and a distinction he makes between two stages of the group creative process which have, in past research, been mistakenly classified together under the same heading. These two stages are 'the creativity stage', the part of the creative process dedicated to "thinking about new things" (West and Rickards, 1999) and the 'implementation stage', the moment in the creative process when ideas are implemented and action replaces thought.

In a later paper, West goes on to explain how external demands placed upon the group affect these two interdependent stages in very different ways (West, 2002). The 'creativity stage', which thrives on open environments and unconditional positive regard, is inhibited by external group pressures, whereas the 'innovation stage' is affected by what West describes as the "burning platform" effect. The burning platform effect describes how innovation implementation is stimulated by pressures external to the group – such as deadlines, targets and criticism.

"What is suggested therefore is that external demands will inhibit creativity which occurs in the earlier stages of the innovation process, but they will facilitate innovation (via innovation implementation) at later stages. Creativity requires an undemanding environment, while implementation requires precisely the opposite" (West, 2002, p.369).

Discussion: creating the optimal environment for small group creativity

I would now like to dedicate the final discussion section of this paper to reflect upon the above research findings and consider how they can be implemented into the 'creativity workshops' I

mentioned in the introduction. This section will be of use to anyone striving to create the optimum environment for small group creativity in, or out, of an educational context.

The first change I would like to consider is in response to West's observation that, while it impacts negatively on the 'creativity stage', external group stress has a positive influence on the 'implementation stage' of the creative process. This observation is in accord with my own experiences teaching on the animation degree programme, where I have often found myself wondering why the ideas generated by students in years one and two are often more adventurous and innovative than those created in year three. On reflection then, this phenomenon could result from the way the syllabus is currently organised, with both the 'creativity stage' and the 'implementation stage' being scheduled to take place during the highly stressful start of year three. I am now considering rescheduling the 'creativity stage' to a less stressful period in the degree programme, possibly even integrating the ideation stage into the 'creativity workshops' that take place in year one.

Aside from rethinking the syllabus, my second objective is to try to adapt the year one creativity workshops so that they become learning environments in which students will be encouraged to reflect upon, and adopt, the various soft skills they need to facilitate optimal conditions for creativity to occur in the small groups they will work in during year two and three of the animation degree. The soft skills I will be focusing on are, for students to:

- Avoid seeking cognitive closure too soon in the creativity stage of the group creative process.
- Become more aware of how criticism can shut down creativity and adversely affect group cohesion during the ideation stage.
- Be aware of the negative effects dominance and hierarchical top-down leadership can have on group creativity, task orientation and group integration and to encourage an environment where open exchange of ideas is possible.
- Practice active listening when other group members are sharing their ideas.
- Become aware of the concepts of 'safekeeping self' and 'experimental self'.
- Understand how difficult it can be to offer up new innovative ideas and the importance of creating an atmosphere of 'unconditional positive regard' within the small group setting, especially during the 'creativity stage'.

I have also been considering how these soft-skills could be imparted and have been exploring the possibility of using Kolb's concept of the experiential learning cycle.

"According to Kolb's four-stage learning cycle, immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experiences" (Kolb et al., 2001, p.45).

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Figure 2: Diagram of Kolb's Experiential Learning Cycle (Kolb D.A. 1984)

An example of how Kolb's experiential learning concept might work in the creativity workshops is for a group exercise to be designed to highlight one of the soft skills listed above – for example, the concept of cognitive closure. Following a practical exercise, time would be given for reflective observation during which students could discuss and consider what unconscious forces were motivating them to bring a premature end to the creative process (cognitive closure). A period of abstract conceptualisation would follow, during which Kruglanski's concept of cognitive closure would be shared with the groups, allowing students to posit suggestions about how they could learn to entertain for longer states of creative uncertainty, in the process becoming conscious of their tendencies to seek cognitive closure too soon. Students would then be encouraged to try out these soft skills in later creativity workshops throughout the semester.

My hope is that, after sessions developed according to Kolb's concept of 'deliberate reflection on experience' (Kolb et al. 2001), student retention would be high and the soft skills learned would help students negotiate their way around some of the pitfalls of group creativity they may encounter in years two and three.

CONCLUSIONS

I am aware that this paper is not an exhaustive study of the myriad factors affecting group creativity and cohesion. However, it has helped me question some of my own assumptions regarding how creativity and group cohesion can be best approached. These findings have also helped me realize how important it is to have a teaching practice informed by relevant research. Research is not simply something that we learn and know, but it can change our ability as educators to perceive situations that we may never have acknowledged before. 25

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MINIMISING EXAM FRAUD BY RETHINKING EXAMS IN CONTEMPORARY E-LEARNING CONTEXTS

Sulanie Peramunagama

ABSTRACT

Online education continues to grow at a frenetic pace. Today, an increasing amount of skill sets, abilities and knowledge is made into content suitable to be learnt or transferred online. Some of the main reasons for this growth might be the flexibility that online learning offers for learners, the increasing use and reliance of technology in day to day activities by young and mature users alike. The rising cost of campus based courses may also steer learners to consider online options as a cheaper alternative.

Naturally, an increasing amount of institutions and organisations are competing to be the transferor of these competencies. Evidence that this growth trend is likely to continue is provided by the percentage of universities that describe online education as being a part of their strategic plans. However, research shows that online education has a positive correlation with dishonesty in academic assessment.

Research shows, the opportunities to cheat increase with the use of technology. With this in mind, institutions that provide online learning, need to accord achievable and adequate, realistic and transparent qualifications to the students in their provision. An online course where qualifications achieved do not reflect the learning gain will lose credibility far quicker than a traditional campus based course, as competition is ubiquitous. After conducting a literature review of online versus on campus exams research, this paper discusses some flaws of online exams that encourage cheating, and outlines an alternative assessment method aligned with the pedagogical intention that may be used instead, one that reduces the motivation and opportunity to cheat.

INTRODUCTION

Today, many employers use the universities' results as a guarantee of proof of learning and therefore employability. Thus, for many, a degree feels like a route to a career rather than an opportunity to learn (Noor 2017). The pressure to pass exams and obtain a competitive job position or get on a higher rung on the salary ladder is constantly increasing. Furthermore, students need to invest considerable financial resources to afford a university degree. When so much is at stake, the motivation to cheat, even to those students who have studied and worked hard, may be understandable. Moreover, given this situation, the knowledge that their colleagues cheat is an incentive to those who might not have considered it in the first place (Ullah et. al. 2016).

Online degrees are gaining popularity mainly because of their lower fee bracket and the flexibility it offers in terms of studying anywhere anytime. Educational content and learning activities are being made available online for an increasingly wide variety of courses and skills. Delivery of course content and learning activities online, have improved and continue to do so at great pace and fervour to satisfy this demand. (Walker et al. 2016, Englander et al. 2011, Allen et al. 2007).

There is a distinction between online courses - those that are free and those that are not. Those courses that have a price tag are the ones that provide proof of learning and competence, which are given preference and looked at by employers as mentioned previously. Among those qualifications, a university degree qualification is substantial. The qualifications are awarded based on the outcomes of the summative assessments. The nature of the expected summative work ranges from essays and other artefacts, to exams and presentations completed individually or as a group.

There is considerable concern and fear expressed by all stake holders about the academic integrity of items handed in by students as part of their summative work; this is relevant to both online and campus based courses. There are a myriad of websites that offer to do your essay or your assignment work for you, and there are plans to crack down on such practices as (Khomami, 2017) reveals.

Be that as it may, most research shows, online (summative) exams in particular, have more incidences of cheating than invigilated exams that take place in examination venues (Beckman et al. 2017, Ullah et al. 2017, Fask et al. 2014, Mcgee, 2013). These and many other papers discuss students' motivation, various opportunities with technology at length. Every new medium of instruction has its own set of inherent inadequacies and problems. Trenholm (2007), mentions that the rate of growth of online learning is outpacing the ability to effectively deal with the issues.

The traditional method of assessment - exams in a venue suitable for 'exam conditions' seems to reign supreme in connection with acceptability and credibility of many on campus based course outcomes. Some online examinations are direct automated versions of traditional paper based exams where the inherent nature of the assessment lends itself to cheating. This paper is more concerned with online exams that contribute to the final summative assessment grades.

DISCUSSION

Biggs (1999), describes two types of learners "academic Susan" who is in university because she wants to learn and "non-academic Robert who is in university because he wants a qualification to get a job. At the time, Biggs said that there is a higher proportion of Roberts than there are Susan's. Today perhaps it is even higher. Biggs suggests in his work that assessment is the single greatest influence on learner behaviour. This has been proven time and time again in other research including Sclater et al. (2007), Boud (2000) to name a few. It is reasonable to assume that many of today's online learners are balancing a work / learn career as well as perhaps family commitments are even more inclined to concentrate mainly on summative assessments and are reluctant to undertake work that does not count towards their final grade. Furthermore, since there are many resources available on the web for learning, they might not even use their own course resources or

lectures. The likelihood is high that they will only focus on or even attempt only the exact activities to get through the summative assessment to obtain the certification needed.

EXAMS

Let us think about periodic summative exams particularly. The Oxford English dictionary (OED) defines exams (short for examination) as "A formal test of a person's knowledge or proficiency in a subject or skill." An exam doesn't necessarily prove a student accomplished the learning, it merely shows that, the particular student answered this particular set of questions in this particular way. Their (exams') most obvious goals are determining if a student can recall information from memory or solve a problem by themselves in an isolated situation in a limited time. A downside of exams that involve recalling information from memory is that some students try to cram as much information as possible closer to the exam but end up being unable to recall some or all of it due to not 'learning' what is required. Also, students who are good at memorising information may be able to perform better than those who cannot.

In terms of the learning gained by the actual exams, it will depend considerably on the feedback given for the answers. If it is an end of module exam, feedback is rarely provided and if it is, rarely given any attention by students as the exam has finished.

Even the most competently designed exam which gauges a student's learning accurately will be useless if any students taking the exam cheated at it.

CHEATING

Cheating is broadly defined as the act or action of fraudulently deceiving or violating rules. The governing principle is academic integrity (Lathrop & Foss, 2000).

Cheating can be in many forms regardless of whether it is a traditional paper based exam or an online exam. Traditional ways of cheating ranged from writing down answers or various formulae on parts of body or kit taken to the exam. More recent ways of cheating in exam locations include sneaking mobile phones into exam venues, using hidden ear pieces and smart watches etc. (Curran et al., 2011). Furthermore, if the work required is in essay or assignment form, the easy access to endless amounts of online articles and publications and the vast amount of "helpers" available over the internet give an unprecedented amount of opportunity and tempt students in to considering cheating. "Students, who in a traditional classroom may never consider cheating, may find the temptation to do so in an online course too powerful to resist" (Bauman, 2002). The work of Trenholm (2007) refers to a collection of research work which found higher incidences of cheating in online exams than in traditional class based courses in higher education as well as the following statistics on cheating:

84% of college students believe they need to cheat to get ahead in the world

90% of college students say cheaters never pay the price; 90 % say when people see someone cheating, they don't turn that person in.

Students say parental pressure (40%), peer pressure (40%), and the availability of new technology (31%) make them cheat.

Trenholm mentions a further study that gives the following statistics on the part friends play in cheating:

37% stated they would give answers to someone on a test67% would use a "stolen" copy of an exam to study for a test

42% would participate in a group involved in e-cheating

Ullah et al. (2016) found that there are incidences of cheating by hacking into the databases where the exam items are stored.

Some teachers or invigilators are "wary about pursuing cheaters" because of a fear of being sued. Those that do pursue cheating allegations often complain that they feel victimised by the process (Trenholm, 2007). Trenholm also refers to the work of Donald McCabe (founding president of the Centre of Academic Integrity, Princeton) which says that "the number of academics who do nothing (about cheating) is very small, but the number who do very little is very large". Ransome and Newton (2017) conducted a study of source texts for postgraduate certificates in higher education (or equivalent) at UK universities and concluded that academic integrity was poorly represented and that it is not clear whether academic integrity features prominently in the education of academics themselves. Either way, it is difficult to prove and give evidence conclusively about various kinds of cheating that students come up with. Although it should be noted that Trenholm's main work was concerned with maths and science based factual courses he refers to online proctoring as "the clearest and most intuitive means for educators to ensure that their students' skill level reflects the grade they receive, and particularly in maths and fact based courses, effectively mitigate any real or potential concern about issues of academic honesty. "

There is little research to be found on the effectiveness of proctoring in online examinations. Harmon and Lambrinos (2008) found that students cheated more in un-proctored online tests than proctored tests, Hollister and Berenson (2009) and Yates and Beaudrie (2009) found no evidence of a difference in incidence of cheating between remote and face to face test contexts, however Fask et al. 2014, and Englander et al 2011, found some flaws in their methods respectively. At least it is reasonable to assume that students will be discouraged to cheat if they know that they will be invigilated online and that it will act as some form of a deterrent.

Although proctored exams may claim to mitigate online exam cheating, there is evidence and belief that cheating can and will occur on these exams. Drasgow, et al. (2009) shows how cheating is accomplished in online proctored exams, where the participants memorise the questions and sell it after they take the test, to "beneficiaries" that buy them. This would be viable in online examinations where because the students are in different time zones, the exams have a longer assessment window. Furthermore there are organisations established online that offer and advertise to 'do the exam for you' for a certain fee. Proctoring relies on the proctor's ability to recognise a face with a photograph of an identity card. There are also websites that explain how to beat online proctoring by including hidden cameras and monitors that an accomplice may use to help the student do an exam [Smith 2016, Hsu 2013].

If we need to have a real impact, we need to address the underlying issue. Why do students cheat? They cheat out of desperation, they cheat to achieve good grades, which they believe in most cases in higher education would affect and impact their entire life and they may cheat because they are not sure about what to expect [Beckman et. al. 2017]. So why not make the course about learning and not testing?

ASSESSMENT DESIGN FOR ONLINE LEARNING

There is the overarching view of researchers in educational technology including Morris et al., (2014), Trenholm (2007), Palloff 2001, that academic honesty concerns should be addressed by the course design and pedagogy.

Beetham and Sharpe (2006) say that "Biggs(1999) describes the task of good pedagogical design as one of ensuring that there are absolutely no inconsistencies between the curriculum we teach, the teaching methods we use, the learning environment we choose and the assessment procedures we adopt." In the case of online courses, and the issues considered so far including academic fraud, it is clear that a change is needed in the way that assessments are designed. Sclater et. al. (2007), propose that there should be a fundamental shift in the way courses are constructed for the web. In addition to that this paper encourages a fundamental shift in the way courses are created so that academic fraud is **designed out** from the very core of the learning experience.

AN ALTERNATE SOLUTION

As the research mentioned above shows it may be the case that having a significant portion of your score coming from an exam leads to a higher prevalence of cheating. Hence the proposal mentioned here is to do away with the exam completely, and use an alternate form of assessment that lends itself much less easily to cheating, yet provides an equally acceptable method of assessing the learning of the student.

This alternate solution being proposed is to rethink or revisit the pedagogy and design the construction of the course so that the teaching continuously adapts itself to the student through frequent micro assessment, and **it is the advancement of the student through the units** that forms the basis of their grade. It is beyond the scope of this article to establish in detail, the implementation of the idea, but hopes it may be useful as a wireframe to educational technologists and tutors.

The following simple example illustrates this idea. Take a module (a subject) that has the units A1, A2, A3, B1, B2, and B3 where the letter represents a topic and the number represents the complexity. If the student completes "1" units, i.e. A1, B1, and a certain percentage of the "2" units, the student will be considered as having passed the course. To gain a merit pass, the student must complete all the "2" units, and some percentage of the "3" units, and so on. Furthermore, a student is only allowed to start on a "2" unit if they complete the corresponding "1" unit to a sufficient level i.e. to do A2, the student must have completed A1 with a sufficient score.

Each unit itself will also be broken down into micro-stages, where the student can only move to each subsequent stage by passing the micro-assessment of the previous stage. Hence completion of the unit is simply the reaching of the end of the unit. This (the completion the unit) should contain learning activities or tasks that when completed, prove the student has gained the learning of the outcome.

Students' activity within the module should be tracked throughout the module.

The completion of the units, in addition to being managed by the software should also provide coherent analytics to tutors on student engagement so that they may intervene when necessary as well as use the information to feed and hone their pedagogy to improve their teaching as well as the design and structure of the course through the online content (Elias 2011).

Note there should also be elements of discussion with fellow students of the course and tutors built and designed as part of the pedagogy of the content design. It is advised that synchronous discussion with tutors(s) be built in to the flow of the work. Bowers et al (2017) and Peacock et al (2015) show in their work that "students' sense of social presence and instructor presence in online courses, influence their overall perception of learning and that students who perceive a lack of social interactions are more likely to withdraw and fail". This may also help towards eliminating identity fraud and pave a way towards tutors getting to know their online students as Rowe (2004) suggests.

PEDAGOGICAL ALIGNMENT WITH LEARNING THEORY

The method breaks down the entirety of the learning required in to units and skill components. The overall pedagogical design is more aligned with the associationist theory which was suggested by Gagne (1985). The author of this paper acknowledges the assumption that the subject matter is such that is possible to be broken down in to smaller parts and learnt as a hierarchy followed based on least to most complexity. The gradual building of patterns and connections maybe achieved when the units are followed with feedback gained after completing the previous sections or units.

Since the assessment of the module is built in to the education technology, it is advised to heed these excerpt mentioned by Peter Knight in Conole and Oliver (2006) on E-assessment. It is that we should ask ourselves two key questions. The first is why anyone should *trust* our cumulative assessment that a new graduate is skilled in the way we say they are? The second is, how people outside our departments may know what sort of performances and judgements a grade we assign, for example such as an upper second signify with it. King warns that in trying to refine our assessment methods that we may neglect or overlook to justify the purpose and credibility of the task.

HOW CHEATING IS REDUCED

This paper proposes that the above-mentioned method will lead to less cheating, for the following reasons:

MOTIVATION

Unlike in the situation where the success of the students' is not dependent on their performance in a few short hours, which may be seen as unfair, but on their performance day in and day out during

the course of the module, which can be seen as more fair, this method is less likely to induce a student, especially a generally honest one, to try and cheat.

Continuing from the previous point, a student will have a very good idea of their final mark throughout the module and can continue to work on improving it. Contrast this to an end of moduleexam system where, no matter how hard the students work, until they sit for the exam there will always be a significant uncertainty about their final exam in the student's mind. This may lead to stress and increase a higher propensity to resort to cheating.

Also the students will know which units to complete in order to get exactly the results they need. They can work on for example completing only up until unit 2. Then their result will be a level 2 pass or merit and that will reflect more closely with what the student actually is capable of. (No uncertainty what so ever about what or how the exam will be like to get the result the student wants).

OPPORTUNITY

It will be much harder to find ways of cheating through a large number of daily-occurring assessments, as opposed to a single exam lasting a few hours. For example, a student may try to find someone to take the final test for them. However, it will be considerably more difficult to arrange for someone to continuously take the micro-stage assessments for them. Such a surrogate would effectively have to dedicate himself to doing the entire course for the student, day by day.

A CAVEAT

One advantage of an end-of-module exam or an on-spot exam is that it tests the ability of a student to retain their learning over a longer period. To cater for this, the following is proposed: To have a "confirmation" test - a periodic test that re-tests the modules that the student completed in that period, for example, in a four month long course, such "confirmation" tests may occur once every month. However, the performance of the student in these tests should not be able to widely change the mark the student accrued by completing modules. For example, if the student has accrued a score of 60% in through module completion, then a very high score in the "confirmation" test may at most increase their score to 65%, and conversely a very low score in the "confirmation" test may decrease their score at most to 50%. The central idea here is the education technology is acting as a moderator who has been building up an opinion of the learning or attainment of the student over time by following the students' progress through the modules. An actual tutor's opinion would not change drastically, no matter how well or badly the student performs in a test that effectively retests the student. Another way to look at is that the student can get a +5% to -10% bonus depending on purely his ability to retain the knowledge.

The reasoning behind this method is that it will not be possible for students to get a significant advantage by cheating at the confirmation test. On the one hand, at most a student can get a slight increase in their score. Furthermore, if we assume that the continuous appraisals give an accurate picture of the students' abilities and learning, then we can imagine that the risk in the students' mind, of their getting a score catastrophically lower than their completion score is low. Hence again, there will be a decreased motivation to try to cheat at the "confirmation" test.

CONCLUSION

Research shows that the incidence of academic fraud has escalated to new heights with the increased development of technology, providing more opportunities to commit fraud.

Fair assessment of student learning is the bedrock that the structures of university qualifications such as degrees and their equivalent classes depend upon. These in turn are relied on most by employers. The threat posed by academic fraud threatens the validity of such courses and the credibility of the institutions.

One of the main streams that academic dishonesty is seen is in online exams. This paper suggested an alternative method of learning assessment for online exams. As with all new learning activities it is suggested to be trialled at low stakes first. The design of such a system will be challenging to educational technologists and tutors, but if successfully explored would make a compelling case to overthrow and replace the traditional online exam that is susceptible to be cheated on.

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A CRITICAL EVALUATION OF THE CRIT: EFFECTIVE FORMATIVE ASSESSMENT IN ART AND DESIGN

Thom Cuschieri

ABSTRACT

This literature review considers some of the challenges at the heart of formative assessment within undergraduate art and design, particularly within the context of the so-called critique by jury (the "crit") framework. The methodology of the crit is analysed and potentially problematic aspects of large studio crits are highlighted. These aspects are presented alongside examples of good practice within an undergraduate Illustration programme that attempts to tackle these issues, such as increased student agency and the use of multiple tutors during feedback sessions. The role of clear formative assessment criteria is also addressed, including the terminology of the various grading bands. Finally, a brief case study of current learning outcomes for a specific Level 5 illustration module is carried out, where strengths and shortcomings are again identified and potential solutions proposed, including an assessment criteria list that explicitly differentiates between technical, conceptual and creative competency.

INTRODUCTION

It is generally well accepted that assessment forms an integral part of the student experience. As Ramsden (2010) notes: "From our students' point of view, assessment always defines the actual curriculum." In their critical commentary on modern assessment practices, Price et al (2011) observe that the assessment process is the aspect of the student experience that students are consistently least satisfied with. They identify seven key premises regarding assessment, amongst them (Premise 4) - "assessment is complex" (Price et al, 2011, p. 5). Creative Arts brings with it a unique brand of complexity due to the very nature of creative endeavours. The fact that there is typically no right or wrong answer to a problem often leads to issues of perceived subjectivity and thus personal preference playing a role. In addition, the personal nature of creative work renders the delivering and receiving of feedback a highly charged emotional affair in which students (and, to a degree, tutors) are often forced to navigate a complex psychological minefield. As Blair (2007) observes: " ... students are expected to learn to self-monitor and self-navigate their own pathway through this 'sea of opinion'." This study will seek to understand some of these issues as they pertain to formative feedback, with a particular focus on the central mechanism by which such feedback is delivered in the context of art and design programmes – the so-called crit. We will approach the subject from two main angles: the methodology of the crit, and the assessment criteria against which work presented during the crit is judged.

In his analysis of the crit within the framework of architectural programmes, Smith (2011) observes that "the crit is likely to continue as the principal if not exclusive method of delivering feedback and conducting assessment in art and design courses, therefore it is imperative that it is conducted in a manner that maximises its contribution to the diverse nature of student learning." In-keeping with this belief, the case is made for more in-depth studies regarding the role of the crit within illustration degrees, which as a discipline carries a further unique set of challenges, situated, as it is, at the crossroads between art and design.

METHODOLOGY OF THE CRIT

"Critique by jury" (Smith, 2011) (commonly referred to as the "crit") is a standard mechanism by which formative feedback is delivered within art and design programmes. During such sessions students are required to present their on-going work on a particular project – showcasing their progress by means of initial ideas, sketches and draft designs – to an audience consisting of their tutors and peers, who then provide verbal feedback on the work and "make suggestions for ways in which it could be further resolved and enhanced" (Parnell et al., 2007, p.5). The crit has been the subject of several critical studies in recent years. Percy (2004) warns against an "...over-reliance on procedural questions and answers pertaining to the project brief rather than a critical engagement with the subject" (p. 152), while authors such as Blair (2006) and Austerlitz and Aravot (2007), discuss the potentially harmful impacts of the crit on students' self-esteem and emotional wellbeing, when insufficient care is taken with regards to the tone and manner of delivery of the criticism. On the other hand, the benefits of the crit within design teaching have also been wellstudied: the crit "encourages reflection and serves as a teaching method through which the student can be guided in the design process" (Healy, 2016); the crit helps prepare the students for the professional world (Dannels, 2005) and is a useful method of measuring a student's ability not just in producing the work but also in articulating their process (McCarthy, 2011).

Crits are typically held at regular intervals throughout the duration of a particular assignment (assuming the project lasts long enough to accommodate multiple crit sessions). The size of the audience (or "jury panel") varies, depending on context. Indeed, a central question at the heart of the pedagogy of the crit is how to run such sessions most effectively, in terms of class size and time allocation per student. In a study of so-called "large studio crits" – that is, crit sessions that are held in front of all (or a significant proportion) of the year group, Blair (2007) describes how students from a focus group "found large crits 'scary' experiences, not just the standing in front of the group and giving a presentation, but also being expected to stand there and to take criticism from the teacher in front of everyone." Such setups have also been found to foster confrontational environments, where "students are focused on 'defending' their actions, rather than on discussion or reflection on the process of learning" (Blair, 2007).

Within the context of design the justification for allowing (and possibly encouraging) a confrontational critical environment is frequently that this constitutes appropriate and useful preparation for the professional world (see, for example, Mills and Goodall, 2012 and Dannels, 2005). Superficially this might seem to make sense: an illustrator will almost always be liaising with both an art director (typically very well informed on the subject) and a client (typically highly-opinionated but possibly less well-informed), and will be expected to take on board critical

evaluations of their work on a day-to-day basis, regardless of whether such evaluations are judged to be well-informed or not. Developing mature methods of handling and responding to different kinds of criticism (and thus learning to navigate the aforementioned 'sea of opinion') is undoubtedly an essential part of the education of an illustrator – but this falls short of justifying a situation where one is effectively expected to take on-board and respond to comments and observations from upwards of, say, fifteen or twenty peers. As Brown (2004) observes: "Surviving this ordeal [the large studio crit] is seen as a rite of passage, something to aspire to, even though no systematic evidence demonstrates that this atmosphere is necessary for the training of professionals." Blair (2006) also questions the validity of this 'professional environment' defence, quoting a practising designer and educator as saying "In practice as a designer I don't know when you talk to a large group – occasionally, but I've never done this in practice. All my presentations were to two, three or four people, max. six people. I have never been involved as a designer where you talk at large groups. It's always been a dialogue."

Size considerations should also extend to the number of tutors present at a crit. Students can often be suspicious of the feedback they have received when the observations seem to stem from whether the tutor likes that particular style of work or not (Mills and Goodall, 2012). The presence of multiple, suitably prepared tutors, has, in the author's experience, led to a much healthier exchange. Students are more likely to feel that the feedback comments are being made in good faith – and being privy to good faith disagreement and discussion amongst the tutors they are more likely to grasp the true nature of artistic and creative evaluation and its myriad complexities. Such a setup leads to a healthy dismantling of the notion of the absolute authority of the tutor – and the associated issue of the "imbalance of power" as discussed by Blair (2006). That said, it is crucial that tutors are entirely in agreement with regards expectations and the nature of feedback to be delivered, as "conflicting feedback [...] is not only unprofessional in the context of providing student feedback, it is also counter-productive as students may be confused by what feedback they should take into account." (Healy, 2016, p.10) This in turn links to the issue of "heterogeneity of marking" (as described by Yorke et al, 2000), though the problems there are largely related to summative assessments, and, as discussed earlier, a calm, reasoned and respectful public disagreement between tutors over a piece of formative feedback can in itself constitute a valuable learning experience for students. Explicit disagreements can, of course, be distracting for students (particularly weaker ones) seeking guidance and assurances from their feedback, and tutors may be able to pre-empt such situations by engaging in public dialogue that clearly seeks to reach a unified position p - as opposed to the kind that indulges the clash of opinions.

With these considerations in mind the author has taken to ensuring that "large" illustration crits at Level 5 consist of a maximum of ten students at a time, with a minimum of two tutors (with the second tutor consisting variably of a department colleague, a visiting lecturer or an industry practitioner) present. Care is taken to ensure the environment is a welcoming and nurturing one: students have a say in both the choice of room in which the crit will take place, as well as the room arrangement (i.e. the relative positioning of speaker and audience), and they are encouraged to think not only about the content of their feedback, but also about the tone and manner in which they deliver the feedback. All these elements help ensure that crit sessions encourage "reciprocity and cooperation amongst students" (Chickering et al, 1987) – rather than animosity and confrontation – and furthermore they help implement the gamification principle of giving students more explicit agency in the manner and method of their assessment. (Wiggins, 2016).

FORMATIVE ASSESSMENT CRITERIA

The crit presents an "important opportunity for an assessment dialogue" (Blair, 2007, p.83), and a "heightened moment of exchange between staff and students in the new landscape of learning" (Percy, 2004). Thus, if handled well, the crit can be seen to "encourage contact between students and faculty" (Chickering et al, 1987). At the same time, these nuanced notions must be balanced with students' desire for practical – ideally, prescriptive even – suggestions for improvement: Blythman et al (2007) found that students often "feel that the lecturers don't tell them what they want and if they do they often change their minds." It would thus seem crucial that the formative assessment criteria be conscientiously designed and clearly communicated to all students and tutors ahead of any crit session, and that the language used during feedback is consistent with the terminology of the various grading bands. Here, too, we find a word of caution in the literature, arising (again) from the specifics of the Creative Arts: "It would be odd for any teacher, nowadays, to dissent from the sentiment that students need to know what they are expected to learn on any given course or module. However, the over-specification of outcomes for the purpose of measurement can be counter-productive in art and design and other creative disciplines." (Davies, 2012, n.p.). On a similar note, Hickman (2007) makes a case for the "gut-feeling" approach to the evaluation of creativity that is available to experts within the field who have developed, some might argue, an innate sense for what works and what doesn't – without a clearly defined set of assessment criteria. Hickman's argument may seem heavily at odds with current accepted wisdom on the subject, but it does highlight the (perhaps uncomfortable) fact that the art world can (and often does) celebrate works that defy any conventional or readily quantifiable notions of visual excellence.

This leads quite naturally to the issue of student agency in the design of the assessment criteria. The ideal scenario is one in which a rough framework is refined through dialogue and discussion between tutors and students, and the primary constraint here is the wording used in the phrasing of the learning outcomes in the DMD. With enough foresight and planning, such outcomes can be phrased in a manner that provides sufficient specificity for the module in question, whilst allowing enough leeway to adapt to the needs of the particular student cohort. In the author's experience, the current set of criteria used on the Level 5 illustration modules (see Appendix 1, for example) are not quite as flexible as they could be, and could do with further iteration keeping the aforementioned considerations in mind.

The question of terminology has received its fair amount of attention over recent years. Harland and Sawdon (2012) discuss an on-going process of standardising the terms used to label grade bands in the Creative Arts. The shift from terms such as "creative", "original", "sound" to plainer language such as "satisfactory", "competent" and "rigorous" marks a concerted effort to reach a common language between tutors and students and to ensure that the feedback conveyed is clear and, above all, useful. Of course, formative feedback sessions should not be reduced to occasions where students merely receive what might be described as an "indicative grade" – indeed the non-prescriptive nature of feedback received during formative crits is a fundamental component of an art and design education (Orr and Bloxham, 2013). However, there is value in seeking out increased clarity and consistency of expression when going from formative to summative assessment, given

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the persistent comments from students regarding the confusion that arises otherwise. Harland and Swandon's approach includes a survey of current grading bands from various institutions, including the University of Hertfordshire. Indeed Hertfordshire's approach is singled out as a system that best encapsulates what the authors describe as one that helps "staff and students build cohesive understanding that appropriately supports student learning in art and design" and addresses "the often inconsistent relationship between criteria and feedback" (Harland & Swandon, 2012, pp.69-70).

That said, Orr and Blaxham (2013), paraphrasing Elkins (2001) in his dissection of the fine art crit, offer terms such as "interesting", "powerful", "moving", "strong" and "compelling" as the ultimate terms of praise: "the words used do not tell you what the work looks like, but the words do tell those who are used to them, how the work can make you feel. Thus we cannot evoke the specifics of the artwork by looking at the 'rhetorical criteria' used." (p.3) These seemingly contradictory approaches highlight one of the issues central to the teaching of illustration: the precision that often accompanies design curricula learning outcomes can sometimes be at odds with the broader, more malleable outcomes one might associate with a fine art curriculum, and a subject such as illustration (that sits squarely at the crossroads) can find itself having to negotiate conflicting priorities.

As a means of focussing on formative assessment challenges specific to illustration, we shall turn to the learning outcomes of a Level 5 Illustration module, as presented in Appendix 1. Whilst generally suited to their purpose, some of these outcomes provide a challenge to the tutor in terms of being able to judge their degree of attainment across the entire range of marks. This is a common enough issue in creative arts assessment that has been frequently addressed in the literature. Cowdroy and Williams (2006), for example, describe how they "[...] attempted to be conscientious and objective in [their] assessment of creative ability and the feedback to [their] students, however, [they] found it almost impossible to explain to students how a particular mark or grade had been derived, and why one student (with a higher grade) was more creative than another (with a lower grade)" (p.99). Similarly, it is hard to explain quite what the difference between a "very good" level of "growing confidence" (with reference to Appendix 1) and an "outstanding" one might be. It is the author's belief that the outcomes and the grading scale both suffer from the fact that they were developed entirely separately and in isolation from one another. The QAA, in its guidance on assessment, states that institutions need to provide for the "effective and appropriate measurement of students' achievement of intended learning outcomes" (QAA 2006:31), and tutors should be in a position to provide examples of work that satisfy each learning outcome and at each grading band. If this is not possible then it stands to reason that one, or both systems need revision – and in particular, that the two should be derived in unison.

Another issue is the conflation of desirable attributes. The ability to present work that demonstrates increasing "competence, individuality and proficiency" covers a multitude of skills that, whilst not mutually exclusive, are often encountered to varying degrees within a single student. Technically competent students are very often less likely to have developed a unique voice primarily due to focussing their efforts on the technical training required in order to develop such proficiency. On the other hand, students with a strikingly original and unique approach might not have the technical competency of their peers as their priorities lay elsewhere (Arisman and Heller, 2010, p.xxvi). It is one of the aspects that distinguishes illustration from fine art that the ability to produce representational, figurative artwork is highly valued – and yet to be a successful illustrator this must

be balanced with the separate skill of being able to carve out one's own unique identity. One possible way of addressing this ambiguity would be to distinguish explicitly between technical, conceptual and creative proficiency and individuality. This is by no means a novel idea (see, Cowdroy and Williams, 2007, cited below), but one which appears to be less prevalent in illustration than it is in more overtly technical disciplines such as architecture and model-making. In this respect, the following hierarchy of levels of creativity and creative ability devised by Cowdroy and Williams (2007, p.105) is highly relevant:

- Level 1: A high level of creativity commencing with conceptualization, and proceeding to iteration through schematization, and to actualization and crafting (leading to realization)
- Level 2: A lesser (intermediate) level of creativity commencing with schematization (without a clear conceptual basis and therefore of limited intellectual foundation) and proceeding to actualization and crafting (leading to realization)
- Level 3: A lowest level of creativity which must be recognized in actualization thinking in conjunction with crafting (leading to realization), but of minimal creative value in the absence of a conceptual foundation and schematic development

Such a scheme does not separate the technical, conceptual and creative strands, but still successfully identifies distinct levels of achievement and the way in which these levels relate to the three strands. One could argue that this is perhaps a more satisfactory way of tackling the issue of ambiguity, as it avoids the need to artificially break up an illustrator's skillset, and there is clearly value in constructing an assessment framework that recognizes the complex, multifaceted nature of creative design work.

CONCLUSION

This paper has sought to identify challenges that lie at the heart of formative assessment in art and design, with a focus on issues arising within the context of an illustration programme. The "large studio crit" was singled out as a standard formative feedback mechanism within art and design that requires careful and sensitive management in order to avoid the creation of an excessively confrontational assessment, as such an environment was found to stifle the effectiveness of the sessions. The issue of ambiguous learning outcomes and associated grading criteria was also addressed, and ways forward were identified, though it is as yet unclear to the author how one might go about the implementation of changes such as the introduction of departmental policy that actively advocates for multiple tutors during crits, and the re-design of module learning outcomes to ensure they are inherently paired to a specific and customized grading system.

With the exception of the magazine article "In the Crit" (Mills and Goodall, 2012) the author has not encountered any formal analyses of formative feedback mechanisms that arise specifically within the context of illustration undergraduate programmes. This is likely due to the fact that typically generic art and design pedagogical theory can be applied wholesale to an illustration context. However, this paper has attempted to highlight some of the interesting problems that arise specifically because of illustration's unique nature as "applied fine art", and it is hoped that with an ever-increasing number of students opting to study illustration (HESA, 2017) there will be an increased interest taken in such pedagogical problems.

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APPENDIX 1: GRADING CRITERIA FOR LEVEL 5 ILLUSTRATION MODULE 5CTA1108 ILLUSTRATION ESSENTIALS PART 2

Module title: Illustration Essentials Part 2

Level: 5

Semester: A

Credits: 45

1. Knowledge & Understanding

Successful students will typically have knowledge and understanding of:

• Techniques, technologies, crafts and materials appropriate to illustration

• How exploration, trial and accident can aid the development of a personal visual language

2. Skills & Attributes

Successful students will typically be able to:

- Present work that demonstrates increasing competence, individuality and proficiency in communicating ideas within the context of a brief
- Demonstrate a growing confidence in self-reflection and the critical analysis of their own work such that they can make informed judgments as to the aesthetic and functional merits of their work

IS VISUAL METAPHOR AN EFFECTIVE TOOL FOR HUMAN RESOURCES DEVELOPMENT WITHIN HIGHER EDUCATION INSTITUTIONS?

Anouska Plaut

ABSTRACT

Metaphors are often viewed as pivotal to the way that we construct meaning and make sense of our world. Visual metaphors are used frequently as a tool for collaborative reflection in Human Resources Development (HRD) workshops yet very little appears to have been written about the effectiveness of these techniques in this context. Facilitators would benefit from further insights into the way that visual metaphors operate, how they promote deeper learning and any challenges they pose for reflective practice. This paper addresses these questions by reviewing literature from related areas of practice such as Organisational Research and Education, highlighting the various strengths of metaphor-based, experiential methodologies including participant motivation, emotional engagement and opportunities for deep learning. The limitations of this technique are also explored, most notably the in-built biases of generative metaphor, and the implications of these for practice. Although there is clearly scope for further, HRD-specific, research in this area, the author concludes that visual metaphor is indeed an effective intervention for staff development and offers a set of preliminary guidelines for best practice.

Key Words: Human Resources Development, reflective practice, visual metaphor

INTRODUCTION

The topic for this article was prompted by an informal conversation with colleagues in People Development at University of Hertfordshire (UH) around the use of group activities involving visual metaphor to engage staff (professional and academic) in learning and development. Many of the workshops designed by this team involve creative exercises to promote collaborative reflective learning for staff participants, but none of the facilitators could offer a pedagogical rationale for their inclusion beyond the value of experiential learning (Kolb, 1984) and an instinct that these would be appropriate techniques. As Human Resources Development (HRD) practitioners committed to reflexive practice, it was felt that further exploration into this intuitive use of visual metaphor would be appropriate and necessary (Salvatori, 2002).

HUMAN RESOURCES DEVELOPMENT IN HIGHER EDUCATION

The role of HRD (known as People Development in some institutions including UH) is to support staff in developing the skills necessary for an organisation to achieve its strategic goals. In recent years, activity in this field has moved from a more traditional training-based approach favouring instructorled interventions, to a more learner-centred process engaging with relevant andragogy and pedagogy (CIPD, 2016). In Higher Education (HE), this takes on particular significance because the context within which staff operate is itself committed to the "business" of learning. HRD activity therefore needs to reflect principles of good practice in this area (eg Chickering and Gamson, 1987; Race 2010). In his work on andragogy, Knowles (1980) suggests that adult learners have important additional considerations to other students, most notably their motivation to learn material relevant to their own particular situation and/or learning goals (Rogers, 2002) and the set of experiences and expectations they bring to the classroom (Rogers, 2007). HRD involves a delicate balance between these "individual needs of adult learners" (staff participants) and "the performance goals of the university" (Knowles, 1980) and interventions are carefully designed with these tensions in mind.

VISUAL METAPHORS AND CREATIVE REFLECTION

HRD at UH offers a programme of standalone workshops open to all members of staff who are interested in developing their personal and professional skills. Each session involves a range of interactive techniques to enable participants to reflect on how they communicate, organise and plan their work and to explore how they might improve their effectiveness in different areas. The groups are kept relatively small and the emphasis is on developing existing good practice, learning new techniques and sharing ideas.

Visual metaphors and other creative learning strategies are frequently used in these sessions to support participants with the process of "making sense of things" (Race, 2010:20), particularly their own practice. Sometimes learners will be encouraged to identify their own metaphors, for example by choosing a particular postcard image that appeals to them, or by selecting a cartoon or animated character to indicate how they might identify with a particular topic or idea. At other times, the metaphors are chosen carefully and deliberately by the facilitator for their resonance both with the topic being covered, and with the participant group (Garner,2005). These metaphors are usually developed through an expressive art-based task, for example building or drawing, encouraging group participation, discussion and have the advantage of layering multiple modes of learning (Sutherland, 2012).

Positive feedback relating to one particular metaphor prompted the aforementioned informal discussion with HRD colleagues and served as a catalyst for this enquiry. At the beginning of *Using Your Time Effectively*, an all-day workshop addressing workload and efficiency, participants are split into small groups, loosely based around their professional roles, and asked to illustrate their workflow as if it were a river. They are encouraged to consider descriptive features such as boulders, current, direction, gradient, as well as the boat they might use to navigate the waters, to extend the metaphor and reflect on individual and collective practice. In their post-session evaluations, participants consistently commented on how this activity enabled them to better visualise and therefore reflect on their work environment. This stimulated an investigation into the nature and effectiveness of visual metaphor as used in this way.

LITERATURE REVIEW

METHODS

Although very little has been written on this particular HRD strategy, in recent years there has been growing interest in the broader application of metaphor particularly in the fields of Organisational Research, Educational Practice, and Coaching. Various searches for a combination of "metaphor", "visual metaphor", "HRD" and "professional development" using *Google Scholar, Education Research Complete* and *ERIC* uncovered substantial literature, about 400 articles in total, devoted to these topics albeit in different contexts. The search was further limited with the terms "Education" and "Reflective Activity" and this identified about 50 articles. Information provided in the title, keywords and abstract resulted in the key texts being selected for inclusion in this paper. Although there were notably fewer references to *visual* metaphor itself, valuable insights were offered into the role played by metaphor more generally which could be applied to HRD activity. This review of key articles and texts will explore the effectiveness of group activities involving visual metaphor for professional learning and development within an HE setting, whilst also exploring potential challenges and highlighting scope for further research.

METAPHOR AND PEDAGOGY

There is considerable writing on metaphor devoted to its role in cognitive processing that has significant implications for learning and development. In their ground-breaking work on conceptual metaphor, Lakoff and Johnson (1980) argue that metaphors are more than just linguistic devices shaping the way we communicate, metaphors structure the way that we think and behave. Their Conceptual Metaphor Theory (CMT) connects two conceptual domains: the "source" – a tangible image or idea such as a river, and the "target" - a more abstract concept, such as workflow, that requires exploration through its link to the "source." By mapping the constituent conceptual elements of the source, for example river volume, current or detritus, to the corresponding elements of the target, for example work volume, flow or obstacles, complex ideas can be brought into view through comparison. According to Black (1962) however, the creative value of metaphor goes beyond simply expressing conceptual similarities. He suggests that metaphor in fact creates similarities by forcing us to make new connections, transforming perspective by fusing two distinct realms of experience. This view is supported by Parkin (2009:66) in her more recent work on tools for trainers, "Linking two unrelated concepts stimulates the brain into making completely new neuronal connections". Metaphor therefore promotes "deep learning" (Biggs, 2003) by providing a "rational bridge" (Petrie, 1979) between the familiar and the unfamiliar, requiring the learner to view things in a new way.

In order to enhance their skills and improve their practice, it is important for staff participants on HRD programmes to reflect on their current performance and consider existing knowledge and experiences. Exploring metaphors can facilitate reflective learning by adding helpful distance to topics being discussed so that participants have space to step back and reflect on their own experiences, draw parallels and create their own new connections (Bruner, 1979). According to Mezirow (1990), this process of interpreting experience through the distorting lens of metaphor creates new meaning and leads to transformative learning. In practice this might lead to workshop participants being able to critically evaluate and reframe their previous experiences whilst also

identifying possible avenues for improvement or change. A number of studies compiled by teachers and other education professionals (eg East, 2009; Hunt, 2001; Perry and Cooper, 2001) highlight these benefits of incorporating metaphors into self-study and reflective activity. In HRD, this reflective activity is usually complemented by a tangible focus on action, for example practicing skills through role-play, to promote learning beyond the abstract conceptual domain and engender real opportunities for change (Clegg et al, 2002).

For metaphors to have any impact as catalysts for learning and development, it is essential that they have *resonance* for the participants involved, there must be familiarity with the "source" concept (Lakoff and Johnson, 1980; Garner, 2005). Learner preconceptions, cultural context and previous experiences need to be taken into consideration when deliberately choosing a metaphor to work with (Garner, 2005; Glynn and Takahashi, 1998). In his work on metaphor and culture, Kovesces (2005) concludes that whilst human cognitive processes are universal, their applications are not and it is therefore important to consider the possibility of multiple interpretations, the "metaphorical entailment potential". Equally, in particular socio-cultural learning contexts, metaphors might be actively selected for their associated or social meanings to deepen connections and promote engagement. Crick and Gushka (2009) explore this in their work on the use of native Australian animals as metaphors for learning power in an Indigenous learning centre

In HRD activity at UH, facilitators tend to use simple metaphors that will most likely be universally recognisable such as rivers or landscapes, but even this approach cannot account for the impact of individual experience (Parkin, 2010; Dunbar, 2016). The river metaphor might hold particular associations for a participant for example, prompted by a near-drowning episode or an eventful holiday on the river. Rather than anticipate every possible response however, MacFadzean (1999) in her work on creative problem solving techniques for industry, cites the importance of an experienced facilitator being able to create a safe, learning environment for participants to work in and feeling confident handling any outcome. Patton (2002) also offers useful guidance for teachers and trainers with some criteria for what makes a good metaphor. In his view, metaphors chosen for a learning and development context need to be:

- Comprehensible
- Connecting with the learner's real life experience
- Meaningful
- Expressing values appropriate to the intended audience
- Appropriate to the situation and context.

So, whilst metaphors can play an incredibly effective role in professional development and reflective learning by promoting a re-conceptualisation of individuals' experiences in light of the new connections they make, their integrity relies to a certain extent on facilitators' careful consideration of *resonance* and context.

VISUAL METAPHORS AND MULTIMODALITY

Most of the literature on metaphor and its application for learning and development reviewed for this paper addresses *verbal* metaphors, critically evaluating the discourse of teachers, trainers and organisational researchers in various contexts (eg Cornelissen, 2006; Hunt, 2006; Martinez et al, 2001; Perry and Cooper, 2001; East, 2009; Carter and Pitcher, 2010; Patchen and Crawford 2011).

HRD facilitators are mostly concerned with *visual* metaphors however and the role these play in facilitating experiential learning (Kolb, 1984). Several studies focus on the value of arts-based methods for learning and teaching in HE, including their application in Information Science (Hartel et al, 2015) and Management Education (Trott, 2010; Ryman et al 2009) . Sutherland (2012) refers to *aesthetic reflexivity* as a process through which learners access the "sensory-emotional characteristics" of their experiences and reflect more deeply as they engage in arts-based learning techniques. Similarly, Van Laren et al (2004) argue that these approaches can extend the value of "mental metaphor images" because there is more room for individual interpretation (Feinstein, 1982) and, often, a stronger emotional appeal (Forceville, 2008).

Feinstein (1982) explores the idea that art is itself a form of visual metaphor which uses a nonstandardized representative vocabulary / set of symbols for which there is little consensus. In verbal metaphor, the *topic* (previously referred to as the *target*) tends to be specified and named, whereas in visual metaphor it is often withheld. In certain contexts, this affords considerable agency on the part of the learner who can apply the conceptual components of the *vehicle* (the metaphoric image) to an enhanced understanding of any number of relevant *topics*. For example, an oft-used technique in HRD is to ask participants to choose an abstract picture postcard from a random selection to express how they feel at the end of the workshop. Participants can use the metaphoric framework of the chosen image, along with any emotional response this might generate, to consolidate reflective learning through the personalised conceptual connections, and any memories, they create. In a similar manner, pictorial metaphors often work better in cross-cultural settings for their enhanced "metaphoric entailment potential" (Kovecses, 2005), their capacity for multiple interpretations.

At other times, the ambiguity of meaning inherent in visual metaphor might in fact result in a lack of resonance for the learner, rendering the learning process ineffective. In her paper on Lego Serious Play, James (2015:7) states how important it is to frame the creative exercise carefully, "getting the questions right" to ensure participants can relate easily and that the process is "rich in meaning, interpretation and scope." Forceville (2008:469) argues that metaphors work best when they are "multimodal", when both target and source phenomena "are cued in more than one sign system, sensory mode, or both," to clear up any ambiguity inherent in pictorial metaphor. Most HRD tasks using creative metaphor are already accompanied by discussion and written or verbal explanation to extend reflective learning, but further attention could be paid to framing activities in a *multimodal* way.

METAPHORS FOR COLLABORATIVE REFLECTION

In HRD, reflective activity using creative metaphor is carried out in small groups. Chickering and Gamson (1987) suggest that working collaboratively in groups can enhance learning and the depth of discussion and the ambiguity inherent in *visual* metaphors certainly appears to increase their value as tools for collaborative reflection, generating deeper understandings of professional practice (Van Laren et al, 2014). Several researchers focus on the reflexive potential of using metaphor drawings in small groups (eg. Van Laren et al, 2014; Van Laren et al, 2016; Tidwell and Manke, 2009) echoing Vygotsky's (1978) work on the social aspect of constructing knowledge from a common experience. Visual techniques are accessible, open to different interpretations and "playful" (Van Laren et al, 2014) which helps to facilitate group discussion around individual experiences, to draw out common themes and, ultimately, to promote further thinking. Comments from participants prompt others to

extend their own interpretations of the metaphor drawing, and consequently to reflect more deeply on their own practice (Tidwell and Manke, 2009).

Whilst "collaborative introspection" (Van Laren et al, 2014) using visual metaphors appears to be an effective approach for HRD, it also poses a number of potential challenges that facilitators need to be aware of. James (2015) argues that facilitation using Lego building technique is highly inclusive and democratic because of its simplicity, but participants may still feel self-conscious or lack confidence in their own creativity. With other arts-based methods, especially those involving drawing, this may have a detrimental effect on participants critical of their own abilities. James suggests this risk can be mitigated with reassurance and motivation from the facilitator. Another factor to take into consideration is the potential impact that a difficult group dynamic might have on the collective learning process. It might be helpful therefore for facilitators to pay close attention to groups, especially through the 'forming' stage of group interaction (Tuckman, 1965), supporting participants with appropriate methods such as icebreakers, ground rules and encouragement (Rogers, 2007).

GENERATIVE METAPHORS AND "HIDDEN MEANING"

Another theme emerging from the literature is the notion of *generative metaphor* (Schon, 1979) which is normative and typically value-laden, posing a different type of challenge for the HRD practitioner. Metaphors often contain implicit assumptions connected to the ideology or values of the person or organisation creating them which can, "generate problem setting and set the direction of problem solving." (Schon, 1979). Morgan (1987) exemplifies this with eight theories of organisations, each based on implicit metaphors that cause us to view, interpret and behave in distinctive ways. Similarly, in their work on metaphorical conceptions of learning, Martinez et al. (2001) argue that a teacher's preferred educational metaphor has the inherent potential to influence their educational practice. If a teacher perceives teaching to be like "taming a horse" or learning to be like "a sponge, which soaks, it is likely that her classroom behaviour will reflect a behaviouristic approach to teaching and learning. For this reason, Carter and Pitcher (2010:588) in their work on metaphor smuggles into the classroom." This counsel could be extended to HRD practitioners by suggesting they remain conscious of any inbuilt bias as they select preferred metaphors for use in the training room.

Although they promote a cautious approach to using generative metaphors, Barrett and Cooperrider (1990) see them as an opportunity for positive intervention in situations of organisational or interpersonal conflict through the reframing of problematic discourse. In his work on organisational metaphors, Cornelissen (2006) argues that simply changing the generative metaphor could in fact have a "creative and transformative" effect. The inbuilt tension in HRD between the needs of adult learners and the strategic goals of the university however, necessitates a particular awareness on the part of development facilitators of any implicit assumptions in the metaphors they select for reflective activity. "Individual reflection cannot … be divorced from the constraints of institutional thinking," (Hunt 2001:283) but the choice of metaphor should at least attempt to liberate rather than further delimit an individual's thinking (Abawi, 2013).

In their work on Clean Language, Lawley and Tomkins (2003) acknowledge that metaphor can be a double-edged sword –enabling learners to deepen their insights through making new conceptual connections, whilst at the same time constraining their perceptions to only those that make sense within the logic of the chosen metaphor. Whilst the aforementioned river metaphor, used in HRD at UH, would appear to be free of any implicit organisational or facilitator bias, participants' reflections and the collaborative discussion will be nonetheless shaped by the conceptual logic of this metaphorical framework. Parkin (2009) and Dunbar (2016) promote an approach, "Clean Coaching" for working with coachees that puts emphasis on the generation of their own metaphors. Coaches are encouraged to be aware of their own metaphoric preferences so as not to project a conceptual framework onto the individuals they are working with. Although HRD is often seen as a balancing act between individual learning needs and institutional goals, this approach could encourage facilitators to identify further opportunities for participants to create their own individual metaphors, thus complementing and extending collaborative creative activity.

DISCUSSION OF KEY FINDINGS

This paper set out to explore the effectiveness of visual metaphor as a tool for Human Resources Development, with a particular focus on its role in collaborative reflective activity. The majority of the literature reviewed explored cognitive processes stimulated by metaphor in the context of teaching, learning and reflective development, and addressed the potential benefits and challenges posed by these conceptual frameworks. Even though this content was drawn from a variety of different contexts, namely Organisational Development, Educational Research and Coaching, the findings lend support and credibility to the UH People Development facilitators' instinctive inclusion of creative, metaphor-based techniques in staff development workshops.

"Effectiveness" in the context of HRD, and in fact more broadly in adult education, is complex and difficult to measure however since it involves a matrix of overlapping factors including individual productivity, organisational indicators and long-term attitudinal change (Kirkpatrick, 1994). It is clear from the literature that metaphor is of immense interest to researchers and there is ample evidence of its immediate or short-term impact as an intervention in the classroom / training room. Further investigation into the impact of visual metaphor and similar creative group-based activities over a longer-term period would be beneficial for HRD practitioners, as might some phenomenological research into the lived experience of participants during these sessions and beyond, perhaps in their place of work Further research might enable HRD professionals to better understand the needs of staff participants and to be able to design more appropriate developmental tools. Additional exploration of the particular needs of neuro-atypical participants who might grapple with abstract concepts such as metaphor might also inform a more inclusive practice.

Whilst no guidance exists as such to support HRD professionals in facilitating collaborative reflective activity using visual metaphors, this review has highlighted several important areas for facilitators to consider if this technique is to be of effective use. These can be brought together as a series of tips for best practice, which may have extended application for teaching and learning outside of HRD.

1. Choose the metaphor carefully, taking into account the sociocultural context of the activity and any prior experiences that may detract from the resonance of the chosen image/conceptual

framework. Simple, unambiguous concepts drawn from the natural world are most likely to be universally relatable.

- 2. Critically reflect on the choice of metaphor to reveal any inherent biases either personal or institutional that might limit the scope of reflective learning.
- 3. Frame the creative activity clearly within the context of the development workshop so that the conceptual *target* of the visual metaphor is clear and participants can focus their reflective learning in an intentional way.
- 4. Support the development of collaborative groups by creating a safe and open working environment, checking in regularly, and offering consistent encouragement to all participants.
- 5. Keep the creative process reflexive by allowing space for participants to discuss their experience of working with the chosen visual metaphor– highlighting the possible strengths and limitations of the particular conceptual framework and deepening reflective insights.
- 6. Try to find complementary opportunities for participants to choose their own visual metaphors for example at the end of a workshop to consolidate an individual's learning and strengthen new connections.
- 7. Continually assess and re-evaluate the effectiveness of visual metaphor as a methodology through in-session feedback and observations, post-session evaluations, peer-observations and reflective writing or conversations.

Although these recommendations offer support to development facilitators using visual metaphor, they are by no means definitive or exclusive to this creative practice. As discussed, Human Resources Development would benefit immensely from further research into the longer-term impact and lived experience of collaborative reflection using metaphorical devices, so facilitators could continue to find better and more effective ways of supporting staff learning and development.

CONCLUSIONS

Based on the evidence assembled through this literature review, it can be concluded that visual metaphor is indeed an effective tool for Human Resources Development through its contribution to the facilitation of deep, experiential learning, as a catalyst for group discussion and as an agent for transformative reflective practice. As long as images can be supported with cues from other symbolic systems such as spoken or written words, the ambiguities inherent in visual (as opposed to verbal) metaphors afford staff participants a unique opportunity to create new conceptual connections, to reflect on their practice and to extend that learning through each other's interpretations.

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APPENDIX

River metaphor - workflow visualisations







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RESEARCH INFORMED TEACHING AS A MEANS TO COMBATTING THE SKILLS SHORTAGE: A PRACTICAL GUIDE

Nada Yousif

ABSTRACT

At present, we are facing a shortage of skilled engineers in the UK, and are particularly lacking high-level technical skills. This shortage is reputedly impacting on the country's ability to compete in the global economy. This article proposes that teaching engineering students up to date skills being used in industry would allow them to be innovative, and is one method by which this can be remedied. In particular, it is proposed that research informed teaching, where current discipline specific research is incorporated into the curriculum, could equip students with the skills they need for a professional engineering role. This paper addresses what research informed teaching (RIT) is, asks why research techniques are invaluable skills for engineers, how RIT is currently being absorbed into university strategies in the UK and critiques how it can be practically implemented for engineering students. The study presents a review of the literature on RIT, an interview with an engineer working in industry and a questionnaire used to evaluate students' perceptions of an RIT inspired learning activity. It is proposed that elements of RIT within an engineering program will help students transition to becoming independent problem solvers, with both the analytical and interpersonal skills valued in the engineering industry.

Keywords: Engineering; Research informed teaching; Skills.

INTRODUCTION

Training engineers is an important issue for the UK at this moment in time, and as reported recently by the Institute of Mechanical Engineers (2016), there is currently a skills shortage in the UK meaning that we are falling short of our potential productivity. In the original Engineering UK (2016) report on which this was based, it is suggested that doubling the number of engineering graduates would be desirable. Interestingly, according to a HM Treasury report published in the year prior to that (2015), a shortage of technical skills is highlighted as the particular problem. Hence, it seems imperative that we train not only more engineers, but engineers with the specialist skills at the cutting edge of knowledge and advances in industry (Litzinger et al., 2011). Such techniques are developing all the time, and the difference between being at the forefront of knowledge or not can make the difference between a successful enterprise or not.

Therefore, this paper suggests that we need to teach engineers current and future practices based on practical knowledge, which in turn has been shown to be more engaging (Heffernan et al., 2010). Such a goal lends itself perfectly to a research informed teaching (RIT) approach, and this approach, with a specific emphasis on training industry ready engineers is discussed below. The structure of the article is as follows, the article starts with a brief introduction to research informed teaching, why it might be important for professional graduate engineers, and then focuses on four ways it can be applied, critiquing the approaches suggested in the literature and that the author has used before.

WHAT IS RESEARCH INFORMED TEACHING?

Research informed teaching (RIT) can be separated into two aspects. The first is using pedagogical research to influence or shape teaching methods or approaches as discussed by Ozay (2012) and this will not be dealt with here. The second is related to using discipline specific research results and methods within the curriculum itself, and this is the flavour of RIT focussed on in this article.

Before proceeding, it is interesting to know how many of the top five UK universities for engineering (according to the Guardian, 2017), have strategic statements involving RIT? As shown in Table 1, all five feature the concept of RIT in their strategic plans or learning and teaching handbook. It must be noted that this trend is certainly not restricted to universities at the top of the league tables, but rather RIT is becoming a universal feature in university strategies. Remarkably, despite the ubiquity of RIT in university strategies, it is still questioned in the educational literature whether research benefits teaching, for example by Prince et al., (2007). However, the question posed by those authors was whether lecturers engaged in research were better teachers. Here the question of whether teaching research skills and research level techniques is beneficial to the student, regardless of whether the lecturer is engaged in research themselves, interested in research, or simply sees the benefit of using research in their teaching.

University	Place in strategic plan	Link
Imperial College	This appears in the College strategy 2015-	www.imperial.ac.uk/strategy/foun
	2020, where the term "research-led	dations/educational-experience/
	curriculum" is used.	
Oxford	In its strategic plan 2013-2018, the	https://www.ox.ac.uk/about/organ
University	university aims to ensure "that students	isation/strategic-
	at all levels experience the intersection of	plan/education?wssl=1
	research and teaching".	
Cambridae	In the University's core values, the idea	www.cam.ac.uk/about-the-
University	that there ought to be a "close inter-	university/how-the-university-and-
	relationship between teaching,	colleges-work/the-universitys-
	scholarship, and research".	mission-and-core-values
Durham University	The topic of research-led teaching	www.dur.ac.uk/learningandteachin
	appears in two sections of the university's	<u>g.handbook</u>
	learning and teaching handbook (sections	
	3 and 7).	
	In the university's education strategy as	http://www.bristol.ac.uk/media-
Bristol	aiming to "incorporating the latest	library/sites/academic-
University	thinking and research, in each subject	quality/migrated/documents/edstr
	area"	at.pdf

Table 1: The table shows the top five UK universities for general engineering and where they have reference to research informed teaching in their strategic plans.

As Griffiths (2004) astutely points out, the mere fact that lecturers are academics, and "that there are different forms of inquiry, or research, taking place in the University setting is a crucial issue in making sense of the research-teaching nexus, because different forms of inquiry vary in terms of how they can be integrated into student learning activities." Furthermore, as academics, it seems natural that we have the desire to either

introduce our own research to students or to present case studies that we find interesting and useful. However, RIT can go beyond that natural passion and interest from lecturers, and Griffiths' (2004) idea that different forms of research takes place at university harks back to a model of RIT by Healey and Jenkins (2009).

Figure 1 shows this well cited model, which includes four broad approaches to RIT that can be used: the vertical axis shows that this can be done in a student led or teacher led manner. The horizontal axis divides the approaches into focussing on research content, or research processes. Each of these is discussed below in more detail, focussing on equipping engineering students with state of the art techniques and skills appropriate to a professional engineer.

Students as participants				
	Research tutored	Research based		
	E.g. discussing	e.g. undertaking		
Posoarch contant	research	research	Research processes	
Research content	Research led	Research oriented	and problems	
	e.g. teaching current	e.g. teaching		
	research	processes		
Students as audience				

Figure 1: Redrawn from Healey & Jenkins (2009). The figure depicts the two axes along which research informed teaching can be aligned. The vertical axis divides approaches into student focussed or teacher led. The horizontal axis divides approaches into being focussed on knowledge or process.

METHODS

This study involves a review of the literature and an examination of the author's own teaching practice. To this end, the author asked eight level 5 students to complete a questionnaire (Appendix 1) on five research articles read during the first six weeks of semester for a journal club. The questionnaire asks students to indicate on a line where they believe their comprehension of different aspects of each paper to be between two extreme states. Such a method has been used previously to measure participants' subjective feelings for example before and after sleep (Herbert et al., 1976). The scores were quantified by measuring the distance for each response and converting them into a percentage of the total length of the line. The scores for the five questions on each paper were averaged to yield an overall comprehension score per student per paper.

DO ENGINEERS NEED TO DO RESEARCH?

It is useful to define what is meant by research. One useful definition was provided almost 40 years ago by Stenhouse (1978) is that research is "systematic inquiry made public". At face value, this can be applied to many different pursuits and professions, which indeed is part of the appeal of such a definition. This paper proposes this idea of systematic inquiry is of huge relevance to the field of engineering.

We can define an engineer as "A person who designs, builds, or maintains engines, machines, or structures" (Oxford dictionary, 2017). This idea of design, build and operate is embedded into engineering degrees, with course contents reflecting these activities well. Importantly, this is also spelled out in more detail in the Engineering Council's accreditation document (2014). This document is critical to higher education providers, as accredited courses are much sought after by students wishing to become professional engineers.

For level 7 MEng degrees, the Accreditation of Higher Education Programmes states that one of the requirements is that students can do the following:

"Work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies."

Similarly for students graduating at level 6:

"Bachelor's degrees with honours are awarded to students who have demonstrated:

• a systematic understanding of key aspects of their field of study"

"• the ability to manage their own learning, and to make **use of scholarly reviews and primary sources** (for example, refereed research articles and/or original materials appropriate to the discipline). "

As can be seen above, the idea of students having both research skills and state of the art skills is embedded in the training criteria for graduate engineers. Hence the idea that an engineering student should have some level of competency in systematic and scholarly investigation to allow them to design and build devices runs through the accreditation requirement.

It is also relevant to look at the work of Brew (2013), who investigated what research is from researchers' points of view. She grouped her findings, which were cross-discipline and geographic location, into four main themes. These were all identified as being part of what constitutes research by the researchers Brew interviewed. These themes she calls conceptions and are as follows:

- Domino: research consists of sequential events, similar to the idea of systematic inquiry.
- Trading: this relates to the social aspects of research, again linked to Stenhouse's idea of making research public.
- Layer: this "conception" is all about uncovering ideas or facts or relationships in data.
- Journey: the last of the conceptions highlights the importance of the personal growth of the researcher, or indeed student.

Brew's conceptions are another useful framework by which we can categorise or understand better what activities or processes constitute research. Interestingly, it appears that there is a great deal of synergy with the simply phrased idea from Stenhouse (1978).

A related aspect of research that will be discussed here is the idea of innovation. Research is often typified by the idea of a contribution to the body of knowledge, or the literature. Again, it seems that this shares aspects with the concepts from Stenhouse and Brew, but solidifies what the outcome of research should ideally be. Engineering at the graduate level, typically involves innovation, or at least aims towards innovation. Individual engineers may be creating the innovation, communicating the innovation or understanding the innovations in order to build on them.

A similar idea is that of evidence-based approaches in professional careers. This idea stemmed from the medical professions, and is taught as part of professional courses for nurses and social workers for example (McKibbon et al., 1998). The idea is simply that when faced with a decision about a practical problem, such as which drug to prescribe, the practitioner should consult the literature, critique the literature, combine the

findings with their professional judgement and make a decision. While this approach might not always be feasible, for example in time restricted situations, it is now being considered important to engineering disciplines (Dyba et al., 2005). Such ideas were echoed in an informal interview with the research and development manager at a company specialising in developing software (Appendix 2). They highlighted the importance of an evidence-based approach in industry, as they commented how their team needed to keep up to date with the state of the art approaches in their field. In conclusion, the idea that engineers should be equipped with both the skills to undertake state of the art research and to critique research.

HOW TO IMPLEMENT RIT TO TRAIN ENGINEERS

In the following section, different approaches to implementing RIT are reviewed with specific emphasis on training industry ready engineers. The approaches are divided into the four sections of the Healey & Jenkins (2009) model for ease, although some approaches may fall into more than one quadrant.

LEARNING ABOUT CURRENT RESEARCH

A critical and straightforward approach is to incorporate state of the art research results into lectures/teaching materials. This allows students to immediately "access to our community of practice" (Lave & Wenger, 1991), which in turn can demonstrate how research is relevant to the topics that they are studying and that it is fast moving as well as highlighting innovation. In addition, this approach can also be used to contextualise or motivate a topic, which might otherwise be felt to be irrelevant by students (Bennett et al., 2006). Conversely, this approach could lead to the undesirable effect of lecturers including research results simply for the sake of it, without cohesion with the rest of the teaching materials. Therefore, care must be taken when encouraging lecturers to take an RIT approach.

DEVELOPING RESEARCH SKILLS AND TECHNIQUES

A second aspect is learning not only about research results, but the methods and processes used to generate research results. This method allows the student to "move beyond knowledge itself to an understanding of how it is generated and contested" (Saffell, 2013). Hence the students can experience a real picture of what happens behind the "closed doors" of research labs for example and in turn appreciate how they themselves could apply such techniques. One example is Saffell's idea of "Story of a paper". The idea here is to use PhD students, faculty or external academics as guest lecturers who present a paper they authored/co-authored. But the focus should be on the practice of doing the research rather than the results themselves. This could also cover important issues such as how the literature review was done, how to generate research ideas, how to obtain funding or ethics, setting up equipment, working with collaborators/team members etc. This could furthermore be extended to "Story of a patent", using the same concept but focussing on applied research and product development, which could be of particular relevance to engineers. This approach is further examined in the next section.

ENGAGED IN RESEARCH DISCUSSIONS

Moving on to the student-led axis in the model in Figure 1, the focus turns to allowing students to think for themselves in research mode. Importantly, this could cover the same ground as the previous two approaches, but has the power of student led active learning (Freeman et al., 2014) and peer learning (Chandran et al., 2014). One approach that will be discussed is a journal club, which the author of this paper has used recently.

On designing the structure, content and assessment for a new module, on a new programme, the opportunity to introduce research informed teaching into both the curriculum and assessment presented itself. Starting

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prior to the first week of teaching, a paper was uploaded to the virtual online learning environment for students to read before the first session. As part of the introduction to the module session, the lecturer presented the paper in a short (five minute) journal club presentation. This set the precedent for the coming weeks. The journal club became an established part of the assessment regime for this module, and though summative is a low-stakes assessment that runs throughout the semester (Rolfe & McPherson, 1995). Students were required to read and discuss the paper as a group in between classes, and each week a different student acted as the chair and presented the paper in class. The group chose to discuss the paper online and they all participated in each week's discussion. Therefore they came to the session guaranteed to have some knowledge of the paper and ready to be involved in peer assessment of the presentation. The inclusion of this activity as an assessed opportunity for students to engage with the literature has been a surprisingly beneficial teaching opportunity. One downside is that as they used the discussion facility on the online learning environment, they each posted a single comment and not more.

Interestingly, the opportunity to combine this approach with the "story of a paper" approach presented itself midway through the semester, when the lecturer chose one of their own papers for journal club. Prior to the students reading and discussing the paper, the lecturer give the story of how the research question came about and the reason for doing the research. The students then proceeded to read and discuss the paper as usual. To assess if this storytelling aspect had an effect on their comprehension of the paper, the eight students were asked to anonymously complete a questionnaire (Appendix 1) on each of the five papers they had read so far that semester and indicate their level of comprehension of five aspects using a visual analogue scale (Herbert, 1976). The average scores per paper are shown in Figure 2 (where 100 is perfect comprehension), and there was no significant difference for the fifth paper compared to the other four. This may indicate that the story of a paper approach does not enhance learning beyond the traditional journal club approach. However, inherent differences in the content of the papers, topics covered, length of the papers was not accounted for in this questionnaire. Nevertheless, the students reported overall good comprehension of and very good engagement with all five papers.

Another student led approach, which could be of particular benefit to engineers, is problem-based learning. The idea here is that students are presented with a problem statement, which can relate closely to the module they are studying and the students need to discuss how to solve it and what knowledge they need. Again, this can incorporate wider issues beyond the core knowledge such as ethics (Mills, 2003). This can be particularly amenable to engineering in combination with case studies and can also bring with it interpersonal skills such as group work, which is important for industry (Nguyen, 1998).



Figure 2: The boxplot shows the results from the questionnaire in Appendix 1. The scores for the five questions on each paper were averaged for each student (n=8). The plot shows the spread of the eight student's average comprehension scores per paper, the white line marks the median and the box delimits the interquartile range.

The final quadrant of the model relates to inquiry-based learning. This is how to work in research 'mode' and acquire the "ways of thinking and practicing" in the discipline (Hounsell et al, 2005). The main way that this appears in engineering programs is via the final year project. This allows them to understand and carry out the whole research process. However, one problem with this is that it typically comes at the end of a program, and is often a big leap for students from having no early experience of this. The author of this paper has attempted to build in elements of inquiry-based learning at level 5, to prepare students for their final year project. Students were asked to undertake analysis of a medical device using a specific methodology, but were left to devise their own question to investigate. The result of this approach was that three of the four groups performed novel research on a medical device, and each of those three on a different research question. A negative outcome could be that some groups feel lost, not knowing how to proceed. But this can be circumvented with careful monitoring. The intention is to allow students to think about what is known, unknown and needs to be known based on the literature.

Another interesting approach is to involve students in competitions, either with real data or as design challenges. Such an approach is encouraged by the accrediting bodies in engineering (for example, the Institute of Mechanical Engineers, iMechE) and provides an accredited method of assessing students. For example the iMechE design challenge (<u>http://www.imeche.org/get-involved/young-members-network/design-challenge-competition</u>), requires students to undertake designing a device. This encourages students to think systematically about a problem, and work in teams to achieve a goal. One pitfall maybe that such competitions may necessitate early engagement, while students often are more pragmatic about time keeping and only allocate more time to a task near the deadline.

Finally, to focus on the public aspect of research as highlighted by Stenhouse (1978) or the trading conception of Brew, the idea of students being involved in, or even organising research conferences, is an interesting one. Conferences are an important part of academic and professional lives, and having students experience the process at different levels can be engaging. Some students can be the organisers or programme committee while others submit abstracts/papers, which can be based on real projects or on journal club papers. Submissions can be divided into poster/oral presentations and the whole process can be integrated across different year groups on a programme to boost the social aspect.

CONCLUSIONS

The uniqueness of learning at a University compared to school or college is that the teachers are engaged in or have direct access to research. For students, this is the added benefit of a higher education qualification and for employers the exposure that students have to research produces graduates with the relevant thinking skills and allows them to understand the practical aspects of research (Ryder et al., 1999). Furthermore, the passion that academics show when talking about their own or new research that they find interesting can be very inspiring, although in my questionnaire example this did not have a direct effect on understanding. If it therefore improves engagement it may also improve results. This article has proposed that research informed teaching can help to train resilient, innovative, collaborative engineers. There are many ways to incorporate research, from teacher led to student led and therefore research can be involved across a wide spectrum of teaching. Like any approach, it can cause problems if it becomes disconnected from what students need, but used in a reflective manner can improve the skills of our future engineers.

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APPENDIX 1:

Questionnaire used with eight level 5 students half way through a semester (6th week), to assess their comprehension of the journal club articles read so far. All text below appeared on the paper based questionnaire, with the title of each article at the top of each page.

For each of the five articles read so far in Journal club, please rate how well you feel you understood the aspects listed. Mark a point on the line which corresponds to your level of understanding. Please try not to take into account how well your classmate presented the paper in class.

Aims of the study	
Not at all	Very well
Motivation for the study	
Not at all	Very well
Methods utilised in the study	
Not at all	Very well
Main finding	
Not at all	Very well
Implications of the work	
Not at all	Very well

APPENDIX 2:

Informal interview with a Research and development manager in a software development company. Questions posed in italic text, transcribed answers in bold text.

- What industry do you work in? Software.
- 2. What is your main day-to-day job involve?

Developing high performance voice biometric solutions.

- 3. How easy would you say it is to recruit engineers with the right qualifications? Extremely difficult.
- 4. What is the crucial knowledge and skills that members of your team should have?
 Coding
 Speech processing
 Machine learning
 To experiment taking into account the challenges of real world products
 Such as scalability, speed of execution
 Follow the evolution of the state of the art voice biometrics
 Analysis and decision taking
- How do you encourage your team to keep up to date with the knowledge and skills they need? Review the program of the main conference in the area Spotting key papers Networking

THE DESIGN OF AN INNOVATIVE, IMMERSIVE, RESEARCH LED, UNDERGRADUATE MODULE FOR EFFECTIVE DEVELOPMENT OF R&D SKILLS AND LEARNING.

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ABSTRACT

Engineering education is currently experiencing a shift in emphasis away from a strongly didactic approach coupled with the study of separate individual subjects where theory is often distinct from application, and where research-led fundamental engineering and vocational training are opposite ends of the curriculum. The result being that many graduate engineers run the risk of being equipped without a thorough grasp of either skill set. The belief that these two components of education can be explicitly separated appears to undermine the notion of what a graduate engineer is. A new approach, moving towards a more immersive, integrated and problem-based environment is gaining popularity, within which engineers can explore both underpinning theoretical constructs, alongside the practicalities of delivering designs and technologies into the marketplace. By evolving engineering education to incorporate problem based learning in this manner it is also possible to further enhance and contextualise aspects of enterprise and entrepreneurialism.

The purpose of this paper is to outline the development of a research informed, undergraduate, module that incorporates the principles of the Massachusetts Institute of Technology developed approach to engineering education where the core components of study are formed around the concept of CDIO (Conceive, Design, Implement, Operate). We outline our initial starting concept for the taught module and systematically break down the CDIO approach, applying the outcomes of this process to the design of the engineering module. The resultant module structure incorporates the majority of the CDIO principles, and highlights the mechanisms by which research can inform undergraduate teaching without straying away from the development of practical skills required by the graduate engineer. This work suggests that the CDIO approach, with minor modification, can be tailored to a single isolated module structure as well as a whole curriculum provided that there is a clear objective outlined at the start.

1. INTRODUCTION

Engineering has long been taught as an undergraduate subject across a wide range of institutions, each with their own specialism within the field. In many cases these institutional specialisms are the result of new emerging industries, historic reputations in selected areas of research or the periodic recruitment of staff with particular, usually relatively narrow and focussed, research interests. In conjunction with this the UK Engineering Council publications; UK Specification for Professional Engineering Competence (UK-SPEC) and the Accreditation of Higher Education Programmes edition 3 (AHEP3) set out the requirements to provide a balanced but very wide ranging set of learning areas that aspiring professional engineers require an underpinning appreciation of and competency in. It should be noted that the UK-SPEC, AHEP3, the Engineering Council, and typically the UK Professional Engineering Institutions, avoid being prescriptive in how these areas are developed, delivered, assessed and taught.

In many cases the incremental development of a degree course can result in fragmentation or broadening of the taught material becoming disassociated from the practice of engineering (Crawley, 2002) in part due to time constraints but also due to a change in focus towards research. Added complexity also results from a desire by external actors and organisations to see ever more content included in courses to meet emerging trends. Rarely does anyone suggest content that should be removed. As a result, there is a risk that students end up having a detailed top level approach to simple engineering problems, but lacking a thorough understanding of the underlying principles required to resolve more complex issues. Research conducted by both Jenkins (2000) and McNay (1999) suggests there is further fragmentation between the research and teaching aspects in higher education. This is evident in the engineering curricula for the majority of degree courses across the globe, where they are content heavy, primarily linear in nature (with a focus on theory in initial years, with more specialised application later) and, in general, present relatively few opportunities for students to be immersed in an end-to-end product development lifecycle. In recent years there has been the emergence of greater enthusiasm for a more immersive experience for engineering students. These are variously described as problem-based, project-based, hands-on or, as the focus of this paper CDIO. This approach has been actively pursued by a number of education sectors, especially Medicine and Dentistry, with some engineering departments, such as Massachusetts Institute of Technology, Olin College USA, Imperial College, Manchester University and in part in engineering at the University of Hertfordshire, increasing their PBL provision year on year

As a result of this apparent increasing fragmentation associated with engineering education, researchers at the Massachusetts Institute of Technology identified and codified a set of goals for engineering education. These goals were developed with the intention of providing a basis for curricular improvement and outcome based assessment, the result being "The CDIO Syllabus: A Statement of Goals for Undergraduate Engineering Education" (Crawley, 2001; Crawley, 2007). CDIO (Conceive, Design, Implement, Operate) aims to provide the necessary structure to create a rational and complete set of goals that are considered to be both universal and capable of general application. Specifically the system focuses on personal, interpersonal and system building skills with complimentary structural placeholders to allow for the inclusion of any discipline specific subject knowledge that may be required.

Fundamentally the CDIO initiative aims to address the growing tension between the two primary factors governing undergraduate education – that of ever increasing subject specific technical knowledge and the wide array of personal, interpersonal and system building knowledge required of a novice engineer in a real world environment. Both are critically important to produce engineering graduates with the competency and capability to tackle previously unseen problems, using technology and business processes throughout their careers that in many instances won't exist now, and for engineers to function effectively in a multiprofessional environment frequently under considerable external scrutiny.
The focus of this paper centres on recent developments at the University of Hertfordshire (UoH). This University offers a number of engineering courses across a variety of disciplines including aerospace, automotive, mechanical, electronic and civil engineering. To compliment the undergraduate and postgraduate taught courses there is also the opportunity to further specialise within a number of applied research groups, each covering a more specific subset of the engineering field. The Microengineering and Microfluidic Systems (MEMS) Research Group is one of these groups that offers a module on the engineering course. Consisting of five post-doctoral researchers from five separate engineering disciplines MEMS, spearheaded by Professor of Microtechnology, Mark Tracey, research and develop novel microfluidic solutions for the biochemical, defence and microfluidic industries. The multidisciplinary, integrated nature of this group is considered atypical, whereby most other research groups typically have a more homogenous focus. It is this distinction that will be examined to determine whether the MEMS group structure can be embodied in a taught module, whether this lends itself well to the principles of the CDIO syllabus and whether this approach can be deployed to modules with less variability in discipline speciality. The MEMS developed Microengineering and Microtechnology (MTech) final year undergraduate module will be a test case for the approach. In addition, while research focus has been attributed by Crawley as one of the possible reasons for the decline in engineering capability of undergraduate students (Crawley, 2002), it is the long established view, as echoed by Humboldt (1810, translated 1970) that Universities should treat teaching as a subset of research itself, whereby "learning always consists of not yet wholly solved problems", including researchers in the teaching programme clearly lends an added skill set to the learning programme.

2. AIM

The objective statement derived during the development of MIT's CDIO approach is particularly true for the emerging field of microfluidics and microtechnology whereby the assumption is that students should be able to:

"Conceive, design, implement & operate complex value-added engineering systems in a modern team-based environment"

Furthermore, institutions that seek professional acknowledgement of engineering degree courses by the Engineering Council would seek to conform to the guidelines set out in "The Accreditation of Higher Education Programmes (Third Edition)" (AHEP3). Briefly this incorporates the UK Standard for Professional Engineering Competence and has an emphasis on learning outcomes rather than inputs, which have been developed in consultation with the profession and include input from employers. It has enabled the development of diverse provision, without losing sight of the required skills, knowledge and understanding that tomorrow's engineers will need with a specific focus on ensuring that theoretical and practical application of engineering principles are met.

With the expectation that Universities should, where possible, review and refine their undergraduate offerings on a continuous basis, the aim of this study is to investigate whether the application of the concepts embodied by the CDIO approach can be applied to the development of a new, research informed, undergraduate module targeted at the final year engineering student at the UoH. To add further complexity, the module will reflect the interdisciplinary nature of a real world engineering department and as such will be offered across two dissimilar engineering disciplines (Mechanical and Electrical Engineering). The result of this process will be the development, delivery and support of the MTech taught module.

3. BACKGROUND

While it is often true that first year undergraduate engineering students share common components of study, generally the expectation is that the teaching becomes more subject specific and promotes enhanced specialism with each successive year. Such an approach, whilst developing sound theoretical underpinning knowledge and understanding in early years of study, and layered onto this more in-depth skills and subject appreciation in the latter years of study, often overlooks the critical importance of interactions between disciplines, and the integrated systems approach necessary in modern engineering projects. While this mode of academic study may develop graduates that reflect the specific departmental needs of larger industrial organisations, where large departments of specialism may be found, it can result in skills gaps for the graduate employee of smaller, high tech start-up industries, of which the Biotech industry is a prime example, and the needs of large multidisciplinary engineering project teams.

As a result of this potential skills gap a new multidisciplinary module was proposed. The aim in this instance was to incorporate different specialisms of an already well established and diverse research group into the undergraduate engineering syllabus. The module developed would be proposed as an elective module for both mechanical and electronic cohorts with the respective alternative modules: Manufacturing strategy, and Telecommunication Systems. An initial framework for this module was developed centring on a number of principles of good practice as outline by Chickering and Gamson (1987) and incorporating the expectations of the UK Professional Standards Framework (The Higher Education Academy, 2006). In particular, the interactions between student and faculty was considered to be a primary focus and thus the module was constructed around a backbone consisting of a group project case study, centred on one of the internationally recognised research outputs of MEMS (Johnson et al. 2005). In small groups with dedicated, interconnected roles the initial aim of the proposed structure was to encourage reciprocity and cooperation, a view enhanced by the opinion of Springer et al (Springer, 1999) who report that the implementation of various different methods of small-group learning are effective in promoting greater academic achievement, more favourable attitudes toward learning, and increased persistence in particular in relation to science, mathematics, engineering and technology. Furthermore, by providing access to the entire MEMS research team it was anticipated that further interaction between the students and the faculty could be achieved. Lecture sequencing was designed to allow flexibility and remove potential barriers to success. A single point of contact, the Module Lead, oversaw the delivery of the module ensuring coherence in the structure and message conveyed by different staff.

Another fundamental principle of the proposed module structure was to communicate high expectations; thus students would be tasked with developing a variant of a device that was itself developed by a team of post-doctoral researchers. The challenge in this instance being one of pitching the objective appropriately such that it wouldn't become too daunting or onerous a task while maintaining the ethos of a cutting-edge development. Additionally, the initial scene setting for

the module centres on an analysis of two seminal works within the field, that of Nobel Laureate Richard Feynman (Feynman, 1992) and Stanford Professor George Whitesides (Xia, 1998).

It was anticipated that the module would naturally incorporate a wide range of teaching styles and learning opportunities due to the diverse coverage of subject material and the inclusion of specialist researchers on the teaching body. The use of hands-on laboratory practical sessions coupled with an informed lecture series would further allow students to put theory into practice. Finally, complimentary tutorial sessions covering analysis tools, both computational development tools and experimental metrological equipment, were built-in providing an opportunity for students to find an area in which they excel. The initial concept, as shown in figure 1, was considered to be sound, though potentially lacking "punch" in its intended outcomes.



Figure 1. Conceptual interactions of the Microengineering & Microtechnology (MTech) module.

As a result of post-development analysis it was perceived that the model followed by the Massachusetts Institute of Technology's CDIO syllabus could be implemented to further strengthen the modules structure and emphasise the core principles of the module with the aim of reinforcing the intended learning outcomes of the MTech module.

4. APPLYING THE PRINCIPLES OF CDIO

The CDIO Initiative is designed as a template which can be adapted and adopted by any university engineering department. As an open architecture "framework" CDIO is available to all university engineering programs and the platform can be adapted to their specific needs. Participating universities (often referred to as "collaborators" within the CDIO literature) regularly develop materials and approaches that are shared across a multitude of universities.

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For the purpose of this study it is not our aim to fully apply CDIO but rather to encompass the philosophy of the approach. It may be considered that this process may form an initial trial in advance of further analysis of CDIO and its wider application to the engineering courses at the UoH. In this regard while CDIO is considered to be a whole programme approach; a means of developing a series of modules each targeted and developed in order to achieve a specific aspect of the overall CDIO aim, this study will instead distil the concepts and processes embodied by CDIO, condensing them where possible and applying these to a single module structure. This study will assess whether this distilled process can successfully be applied to a single module, or whether the CDIO approach can only be applied on a whole programme basis.

In order to extract the core information of the CDIO approach it is necessary to appreciate the complete CDIO adoption process (see figure 2).



Figure 2. Diagram outlining the complete CDIO adoption process (Crawley, 2001)

The adoption process as highlighted in figure 2 provides a clear managerial structure for the adoption of CDIO. The starting point for this lies in the application of twelve successive standards. Broadly these are as follows (Crawley, 2001):

- 1. CDIO as Context: Adopt the principle of Conceiving, Designing, Implementing, and Operating as the context for engineering education.
- 2. Syllabus Outcomes: Specific, detailed learning outcomes for personal, interpersonal, and product and system building skills, consistent with program goals and validated by program stakeholders.
- 3. Integrated Curriculum: A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal, and product and system building skills.

- 4. Introduction to Engineering: An introductory course that provides the framework for engineering practice in product and system building, and introduces essential personal and interpersonal skills.
- 5. Design-Build Experiences: A curriculum that includes two or more design-build experiences, including one at a basic level and one at an advanced level.
- 6. Workspaces: Workspaces and laboratories that support and encourage hands-on learning of product.
- 7. Integrated Learning Experiences: Integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal, interpersonal, and product and system building skills.
- 8. Active Learning: Teaching and learning based on active experiential learning methods.
- 9. Enhancement of Faculty CDIO Skills: Actions that enhance faculty competence in personal, interpersonal, and product and system building skills.
- 10. Enhancement of Faculty Teaching Skills: Actions that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning.
- 11. Skills Assessment: assessment of student learning in personal, interpersonal, and product and system building skills, as well as in disciplinary knowledge.
- 12. Program Evaluation: A system that evaluates programs against these twelve standards, and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement.

The MEMS group employed both top-down and bottom-up approaches to the application of the 12 standards. With the exception of standards 11 (Skills Assessment) and 12 (Programme Evaluation) the remaining standards were applied and assessed during the development stage of the module. Standards 11 and 12 have been implemented at the design and development stage however by default these are reflective standards and successfully attaining these can only be achieved at the end of the planned delivery period for the MTech module.

5. ADOPTING THE STANDARDS

5.1 STANDARDS 1 AND 2

The initial process requires that standards 1 and 2 are adopted at a corporate philosophical level, subsequently the context, program aims, and specific goals for learning should be outlined.

In this instance the MTech module is positioned as a second semester final year module, thus it should be considered as one of the last remaining taught modules before students graduate and either enter further education or engineering employment. In this context the MTech module emphasises that each student is expected to work in collaboration with all other group members, to identify technical issues and solutions together, and to share the decision-making processes – key skills required for industrial collaborative engineering work. Group work is managed through an online repository of group discussions, working documents and meeting information (agenda and minutes as required). Individuals allocate team members an anonymous Peer Assessment mark (moderated by the teaching body) related to the involvement, attitude and output of each member

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in the team. It is also clearly communicated to students that it is not sufficient for each student to do their own work in isolation – each student should also take part in the group discussions and decision making, provide work at the agreed time and to help others within their group as required.

The module aims as indicated by the Definitive Module Document (School of Engineering & Technology, 2011) are set out as follows:

- To develop an understanding of the principles required for innovative, integrated microengineering design and manufacture.
- To further develop students' ability to work in multidisciplinary teams to design a microengineering product.

Furthermore, the specific learning outcomes are split into two primary categories, Knowledge & Understanding and Skills & Attributes, whereby a successful student should be capable of the following in order to satisfying the Knowledge and Understanding outcomes:

- Demonstrate an understanding of the engineering principles appropriate to the design of a microengineering product
- Demonstrate an understanding of the manufacturing considerations particularly appropriate to a microengineering product

and capable of the following in order to satisfy the Skills & Attributes outcomes:

- Apply appropriate analysis techniques to assessing the performance of a microengineering product.
- Work effectively in a multi-disciplinary team and communicate the development and outcomes of individual, as well as group project, work.

Subsequently the initial program outline was benchmarked against four key components: overall curriculum, use of workspaces, specific approaches to teaching & learning and finally assessment practices. As a component of the existing School of Engineering & Technology programme the module also contributes to the externally benchmarked professional standards (AHEP3) as required for accreditation by the Institute of Engineering & Technology (IET) and the Institute of Mechanical Engineering (IMechE).

5.2 STANDARDS 3 TO 12

While Standards 1 and 2 are primarily philosophical, standards 3 – 12 require the practical implementation of the module design and the identification of key themes and resources was the primary driver. In each of the key areas (Curriculum, Workspaces, Teaching & Learning and Assessment) the module design was analysed and restructured, areas for improvement where identified and redesigned leading to activities that satisfy the CDIO Standards 3-8. Specifically, the resultant MTech module provides both mechanical and electrical engineers with a base understanding of the principles required for innovative, integrated microengineering design and manufacture. This reaffirms aspects of the underlying engineering principles that's students have learnt in previous years such as engineering design, materials, manufacture and the use of system

analysis tools (such as Finite Element Analysis [FEA], Computational Fluid Dynamics [CFD] and Electronic system simulation. In addition, students learn microengineering specific subject material such as microfabrication, precision metrology, microfluidics and Microelectromechanical Systems [MEMS]. Cementing the application of these engineering principles is the core of the module itself that consists of a case study led group project focussing on the design of a microfluidic pump (itself a research output from MEMS). The individual members of the project groups follow a documented plan that integrates CDIO required skills with technical disciplinary content and exploits the appropriate disciplinary linkages. This is supported by appropriate inclusion of learning outcomes in both formal and informal study requirements. In this instance formal study is taken to mean study which dictates a specific structured process and submission, informal study only dictates the submission requirement encouraging students to develop the process required to satisfy the outcome. Both faculty staff and students alike are aware of the intended learning outcomes of the curriculum, reiterated at the start and end of each formal teaching session.



Figure 3. Diagram outlining the complete CDIO adoption process

The group project aspect of the module incorporates learning experiences that introduce essential personal, interpersonal, and product and system building skills where students acquire the learning outcomes described in CDIO Standard 2. The MTech module, being an elective module, engages students at the highest level in their chosen field of study; this is encouraged by the application of directed class discussion and guided by formative assessment of understanding via survey or electronic voting system (EVS) during seminar sessions, the use of this technology has been found to promote interactive engagement, helping to launch peer discussions and enable contingent teaching (Draper, 2004). In the case of the MTech module the opportunity for contingent teaching is of high importance based on the mixed background and prior knowledge of the student body.

The group project leads to one fully realised design-build experience during the course of the module curriculum; this design-build exercise requires co-curricular support at a peer level for design-build and includes support from the research laboratory staff. Finally concrete learning experiences are emphasised by the self-directed group roles which provide the foundation for subsequent learning of specific disciplinary skills. Throughout the module students have access to

adequate spaces equipped with modern engineering tools, in particular computer-aided software analysis tools, however the students are also encouraged to develop an understanding of the manufacturing processes of Microtechnology via access to a class 1000 microfabrication clean room.

Students are encouraged to be active learners, directed by a project brief and intended outcome but with student led flexibility in the means of satisfying the brief. Students are required to accurately document this process and self-report as well as self-assess (via moderated peer assessment). This inclusion of self and peer assessment processes has been shown to be an effective method of encouraging student learning (Falchinov, 2000; Sadler, 2006).

To ensure further comprehensive completion of the CDIO requirements additional measures were put in place to strengthen the module and enhance faculty competence in teaching, learning and assessment (Standards 9 and 10). By design, the MTech module incorporates the output of research staff that have themselves shown competence in personal, interpersonal, and product and system building skills. This is demonstrated to students through the use of previous research outputs and publications relevant to the MTech project. Being able to draw upon physical engineering output communicated the experience in engineering practice of the teaching staff. Added to this each member of staff teaching on the MTech has attained post doctorate level academic qualifications; to support this staff have undergone additional Continuous Professional Academic Development (CPAD) in learning and teaching.

The final requirements for satisfying the CDIO criteria are centred on assessment and evaluation (standards 11 and 12). The assessment process applied to MTech includes continuous assignments from the outset, each targeting a specific skill and building on the concepts embodied by the formal teaching session, in all cases the students are informed of the specific learning outcomes targeted by the assessment. Furthermore, to encourage diverse ways of learning a variety of separate assignment types cover each of the learning outcomes and provide a number of mechanisms to instil these learning outcomes in each of the students. The overall module classification attained by the student is determined based on reliable and valid data gathered during the course of the module. Two individual assignments are allocated in weeks 1 and 3, these marks are used to form a baseline of the individual and to identify potential areas of weakness. These are flagged and individual feedback is provided for general development (applicable to all assessed modules) and specific development within the MTech module. Continuous learning is assessed via weekly class test using the electronic voting system (EVS). Group work consists of submission of key components at appropriate developmental milestones (Concept development, theoretically analysed designed ready for manufacture, group report, and final presentation). The final report is submitted jointly with each individual contribution clearly identified. In this way individuals are recognised not only for their own abilities but also their contribution to the success of the project.

Finally, the MTech module has been constructed with the input from a wide range of key stakeholders including Learning & Teaching Specialists, Subject experts, industry partners, and the teaching body of the MEMS group, each of whom has individual responsibility for the evaluation of key components of the module. Program evaluation methods, such as EVS, are built into the core of

the module to gather supporting data from students during the module. Instructors, programme leaders and other key stakeholders have identified mid points during the module where an evaluation of progress can be evaluated and documented; this will form the basis of data-driven changes as part of a continuous improvement process.

6. RESULT OF THE PROCESS

Based on an initial design for a research informed module in microengineering and microtechnology we have systematically applied the concepts embodied by each of the standards outlined by the CDIO approach. The application of the CDIO structure highlighted limitations in the initial consultancy process for the module design.

Specifically, a number of principles of good practice as outline by Chickering and Gamson (1987) required further consideration, these being:

- encouraging active learning
- providing prompt feedback
- emphasizing time on task

The application of the CDIO standards has resulted in an undergraduate module that now incorporates all seven of the principles of good practice including those outlined above. The module communicates a high expectation of the students, with directed study and assignment commencing with the start of the module, feedback is provided both formatively and summatively as appropriate to the development of both the assignment structure during the module as well as the student interest level and promotes further reading with directed key texts. The final structure for MTech delivery is shown in table 1.

Week No.	Lab/Prac Topic	Lecture Topic	Seminar Topic	Notes inc. Assignment Set and Due dates						
1	Introduction to MTech	Introduction to Microengineering	Case study – Microfluidic pump project In Class Test (ICT -EVS)	Group Report set (A1) Group Photomask (A2) Journal Analysis (A3)						
2	Computer Aided Engineering (CAE) intro	Microfluidics	Microfluidics in the laboratory Vs. the real world. ICT -EVS	A3 Due Group Role Form Due						
3	CAE Tutorial – CAD. CFD. CAF	Further Microfluidics	Experimental Microfluidics, ICT - FVS	Journal Analysis (A4) A3 Generic Feedback						
4	CAE Tutorial – CAD, CFD, CAE	Materials for Microengineering	Material choices and design limitations. ICT - EVS	A4 Due						
5	CAE Tutorial – Drop in session	MEMS 1 (Mechanics)	Historical significance of MEMS devices. ICT - EVS	Peer Review 1 Due Review interactions						
6	CAE Tutorial – Photomask	MEMS 2 (Electrical)	The commercial application of MEMS. ICT	between Materials, MEMS 1 and MEMS 2						
7	CAE Tutorial – Photomask	Metrology	Metrology: design support before, during & after development. ICT -	A2 Due Book Open Access Lab						
8	CAE Tutorial – CAD, CFD, CAE	An Overview of Microfabrication	Turning the virtual into reality – complexities and intricacies. ICT -EVS	Peer Review 2 Due A1 Outline and Literature Review						
9	CAE Tutorial –	Core Microfabrication	Review of Group Project. ICT -FVS	Complete Lab work Presentation set (A5)						
10&11	18-11 Vacation Easter Break									
12	CAE Final wrap	Process	Final Report Discussion	A1 Due						
13		AE Droject Droconta	tions Due	Poor Poviow 2 Duo						

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Table 1. Final schedule for Microengineering and Microtechnology as developed using the CDIO

The result of this process was the successful creation of a Microengineering & Microtechnology module, offered as an elective module for final year engineering students studying mechanical and electrical engineering at the University of Hertfordshire from 2011. The initial uptake has resulted in 40 students opting to study Microengineering & Microtechnology in 2011, more students than either of the concurrent alternative two elective modules. The module has subsequently averaged 42 students per year over the 5 years the module has been running.

Alongside pass average and external examination of the course the University also collates individual module feedback from current students via end of module questionnaires. This process provides a qualitative assessment of the module and overall programme from the student perspective. During the 5 year period discussed two variations of the questionnaire have been used, the Module Feedback Questionnaire and the Student ViewPoint Questionnaire. In both cases specific, module related, questions were identical, scored by students from 0 – 5 and their application and implication

on the module can be compared. The relevant questions from the MFQ/SVP questionnaires, question 1 - 8, are shown in table 2:

- 1. The module provides learning opportunities which enable the learning outcomes to be achieved.
- 2. The module is well organised and running smoothly.
- 3. E-learning facilities (e.g. StudyNet) are contributing usefully to my learning on this module.
- 4. The module is intellectually stimulating.
- 5. The criteria used in marking have been clear in advance.
- 6. Feedback on my work is helping me to clarify things I did not understand.
- 7. Feedback on my work is prompt.
- 8. I am able to contact staff when needed (including email and telephone as well as face to face).

Table 2. End of module questionnaire (across all modules at the University of Hertfordshire).

Student feedback was sought at the end of each semester for all engineering modules using either SVP (Student View Point, 2011/12 & 2012/13) or MFQ (Module Feedback Questionnaire, 2013/14, 2014/15 & 2015/16) with the CDIO based MTech module recording an average of ~18% higher that departmental average for the first four year period, by comparison the module received an average score ~15% higher than the University as a whole for the period (Table 3). Initial indications are that changes made to the module during 2015-16 academic year concerning feedback delivery mechanisms (online delivery) have potentially affected the module score for both questions 6 & 7.

Q	2011-12		2012-13		2013-14		2014-15			2015-16					
no.	U	S	М	U	S	М	U	S	М	υ	S	М	υ	S	М
1	4.13	4.17	4.35	4.24	4.15	4.75	4.13	4.05	4.70	4.20	4.19	4.57	4.20	4.17	4.38
2	3.81	3.95	4.35	3.90	3.90	5.00	4.00	3.94	4.60	4.10	4.06	4.39	4.10	3.98	4.31
3	3.69	4.10	4.30	3.85	4.04	5.00	3.96	3.97	4.60	4.12	4.14	4.38	4.10	4.13	4.54
4	3.73	4.04	4.55	3.80	3.97	4.50	4.01	3.85	4.50	4.09	4.07	4.42	4.07	4.00	4.15
5	3.56	3.92	4.15	3.70	3.87	5.00	3.89	3.82	4.60	4.03	4.04	4.44	4.03	3.99	4.23
6	3.20	3.83	4.25	3.47	3.81	5.00	3.67	3.52	4.70	3.87	3.88	4.42	3.85	3.72	3.85
7	3.10	3.85	4.30	3.44	3.80	4.75	3.69	3.61	4.20	4.01	3.99	4.41	4.01	3.88	3.92
8	3.82	4.13	4.50	4.14	4.08	5.00	4.22	4.09	4.80	4.32	4.27	4.63	4.29	4.20	4.23
Avg.	3.63	4.00	4.34	3.81	3.95	4.88	3.95	3.86	4.59	4.09	4.08	4.46	4.08	4.01	4.20

Table 3. End of module questionnaire results compared from 2011 through 2015. U=University wide average, S= School wide average & M= Module average collated from MFQ and SVP data. Light Green – Dark Green represents lowest to highest score per academic year. (University of Hertfordshire Centre for Academic Quality Assurance (CAQA), 2016 [unpublished, personal communication])

While the final distribution of module classification is indicative of the work ethic and input from individual students it is clear to see that the expectation on students can be considered "challenging but achievable". This is evidenced by the average grade achieved by students, falling into the lower segment of the 2^{nd} Class category (60 – 69%) but with a zero failure rate over the 5 years of the



module (below 40%). The average student mark for this module has remained consistent from the outset and averages 63% with an absolute standard deviation of 0.64 (Chart 1).

Chart 1. End of module grade distribution over the first 5 years of Microengineering & Microtechnology module.

7. CONCLUSION

We have designed, developed and delivered a complex research informed and industry relevant module in microengineering and microtechnology that successfully implemented the concepts embodied by the CDIO approach;

"Conceive, design, implement & operate complex value-added engineering systems in a modern team-based environment"

This module has challenged students in a wide range of complex theoretical concepts as well as practical designs and hands-on activity, leading to an enhanced understanding of the role of research and the complexity in applying these findings to the development of innovative engineering products. During development of the module it was necessary to distil the fundamental concepts embodied by CDIO to a module level as the approach is primarily design to be applied on a "whole curriculum" level. The final proposal has resulted in a module structure that embodies a number of principles of good practice from the education literature. The inaugural run of the MTech module was offered as an elective module for final year engineering students studying mechanical and electrical engineering at the University of Hertfordshire. The initial uptake resulted in 40 students opting to study MTech, more students than either of the alternative two elective modules running at the same time. The module has subsequently continued to attract a similar proportion of students from both mechanical and electrical cohorts. The module was offered exclusively to these cohorts from 2011-2012 until 2013-14. From 2014 onwards the module has been extended and is now

included as a compulsory component on two new degree programmes MEng/BEng Mechanical Engineering & Mechatronics (inaugural year 2014) and MEng/BEng degree in Biomedical Engineering (inaugural year 2015). With positive feedback from students, staff, external examiners and validation teams this module, with the aim to be innovative and research led, can be considered a success. The implementation of CDIO approaches coupled with research informed teaching can lead to the development of research and development skills and learning as evidenced by the results of the individual students on this module.

8. FURTHER WORK

To further validate the teaching of research skills and learning it is recommended that a future review of the Destinations of Leavers from Higher Education (DHLE) data could be conducted. This would aim to establish whether graduates from this module are more likely to enter into research orientated further study or employment. With low graduate numbers at present it is anticipated that this study may only provide relevant data once graduate numbers from the MEng/BEng Mechanical Engineering & Mechatronics and MEng/BEng Biomedical Engineering are included in the assessment.

9. ACKNOWLEDGMENTS

The authors would like to thank the School of Engineering & Technology at the University of Hertfordshire for providing the MEMS Research Group with an opportunity to develop and deliver an undergraduate module centred on the research output of the group and for providing the necessary support to get the idea off the ground. The Centre for Academic Quality Assurance for providing access to University wide data and to the Continuous Professional Academic Development Team for their support and advice related to the pedagogy of curriculum design.

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