An ecological approach to educational technology: affordance as a design tool for aligning pedagogy and technology

Submitted by Richard Osborne, to the University of Exeter as a thesis for the degree of Doctor of Philosophy in Education, December 2014.

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

(Signature) ………………………………………………………………………………

Acknowledgements

My PhD journey has been a long one, and like any long journey it has been shared by many others who have joined me along the way. I have been fortunate to have had so many people willing to offer support and guidance, some of whom I would like to thank personally.

I have had my fair share of supervisors over the years, perhaps more than some, and they have all provided a rich contribution to the thesis in their own way. Patrick Dillon and Penni Tearle, my first supervision team, were the ones who suggested I study for a PhD. Without their confidence in my ability I would never have started, and they ensured I set off on my journey down the right path, and with a mind-set that would keep me heading in the right direction. Ben Williamson, although only a brief companion, helped me to see the world in new ways, and led me to new concepts that have proven central to the thesis. Taro Fujita joined my journey later, but without his respectful but firm prompting, his diligent and timely feedback, and his insightful and sharp thinking, this thesis would not have been completed. Finally Rupert Wegerif, who has been my longest companion on this journey, and whose advice has shaped the thesis into what you read today. When I look back at the individual who started this journey, I can see enthusiasm and passion, but also naivety and ignorance. Some of that naivety and ignorance has been replaced by a broader understanding of pedagogy, and a deeper appreciation of the work of others, both of which to a large extent are due to Rupert's prompting and questioning over the many years we have worked together.

To colleagues and students at the School (School A in this thesis) that supported my research I would like to extend my thanks for the time and effort they spent working with me, allowing me to change so significantly their teaching and learning. Their involvement in the research was not only central to its progression, but also fun and engaging.

Many colleagues at the University of Exeter have helped me through this journey, and I will always be grateful for those kitchen chats and corridor conversations which seemed to spring from nowhere, but almost always led to new thinking and renewed enthusiasm. I would like to single out in particular my colleagues from the Collaborate project, Liz Dunne, Stuart Redhead and Charlotte Anderson. You not only endured my endless ramblings about affordances, invariants, and the thinking of James Gibson, but also embraced the concepts I was suggesting, and helped provide the professional environment within which my research could flourish.

Most of all thanks to my family. For my partner, Benedetta, for always being there for me. I will always fondly remember our Sunday lunchtime discussions over this theory and that theory, rambling chats in the car about new ideas in teaching and learning, and evening discussions over my latest draft chapter. You've been endlessly patient with what must have at times seemed like the thesis that would never end. And many thanks to my son Max, for getting in the way so often, and reminding me when to stop studying and start playing.

Finally, thank you Marmite the cat. You kept me company on study days, and always seemed to know which particular textbook it was most important to lay on. You started this journey with me, sadly didn't quite make it to the end, but will always be a hidden part of this work.

Abstract

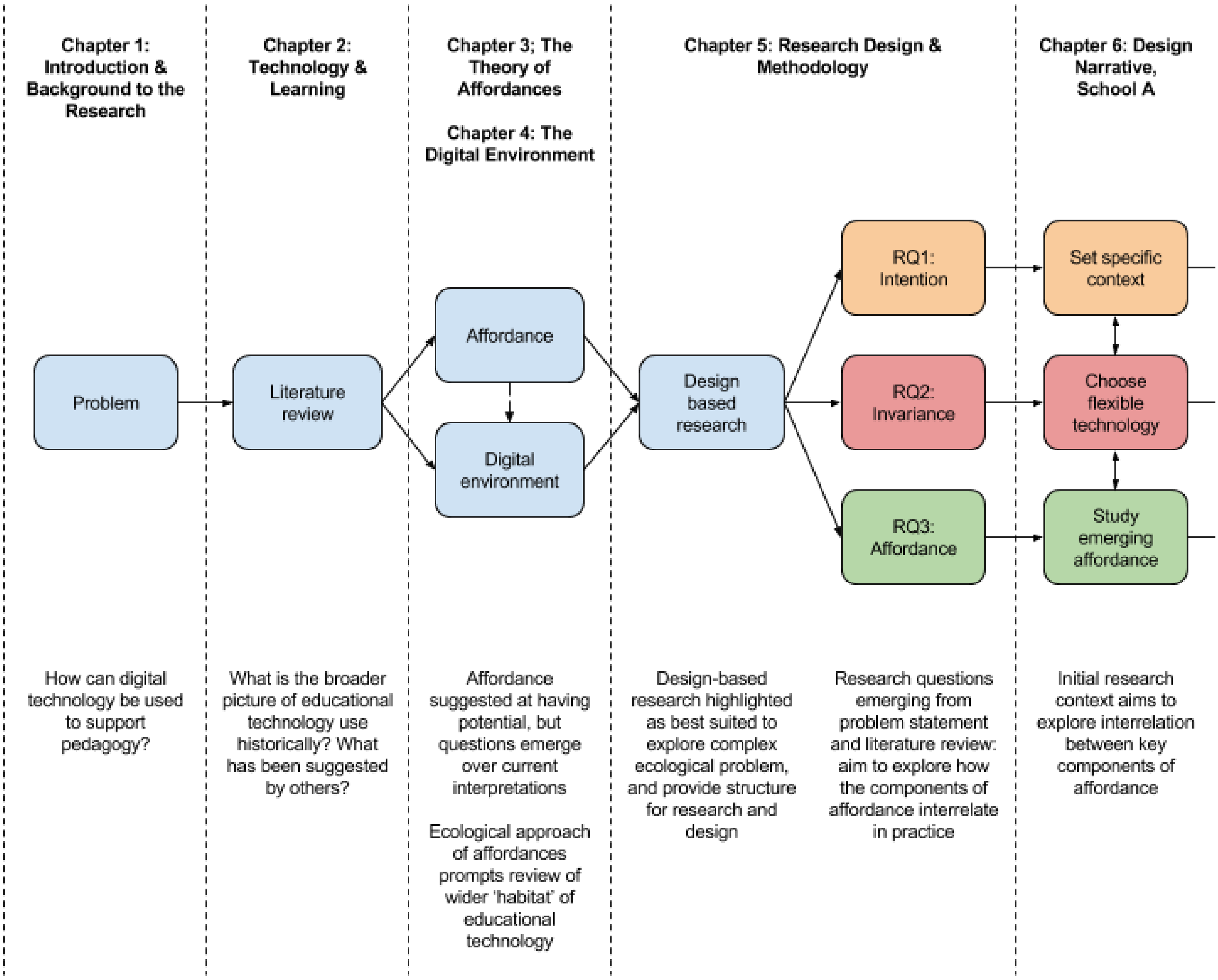
Digital technologies have for many years been acclaimed as tools that hold the power to transform learning, yet educational research has so far failed to demonstrate the transformative effects of these digital technologies on learning outcomes (Cuban, 2001; Price and Kirkwood, 2011). Some research has even gone so far as to question this underlying assumption regarding digital technologies ability to transform education, suggesting that they do not in fact have any inherently positive benefits for learning, and that perceived benefits are actually artefacts produced by other factors (Means et al, 2009). Several potential causes have been proposed for the slow progress in educational technology, including lack of time for staff development, unsuitability of technologies, and cultural barriers within institutions (Laurillard, 2012a). A fourth potential cause may lie with the lack of theory to explain technologies themselves (Oliver, 2013). Different theoretical perspectives have been proposed as a way to enhance our understanding of technologies, with one potential candidate being the theory of affordances.

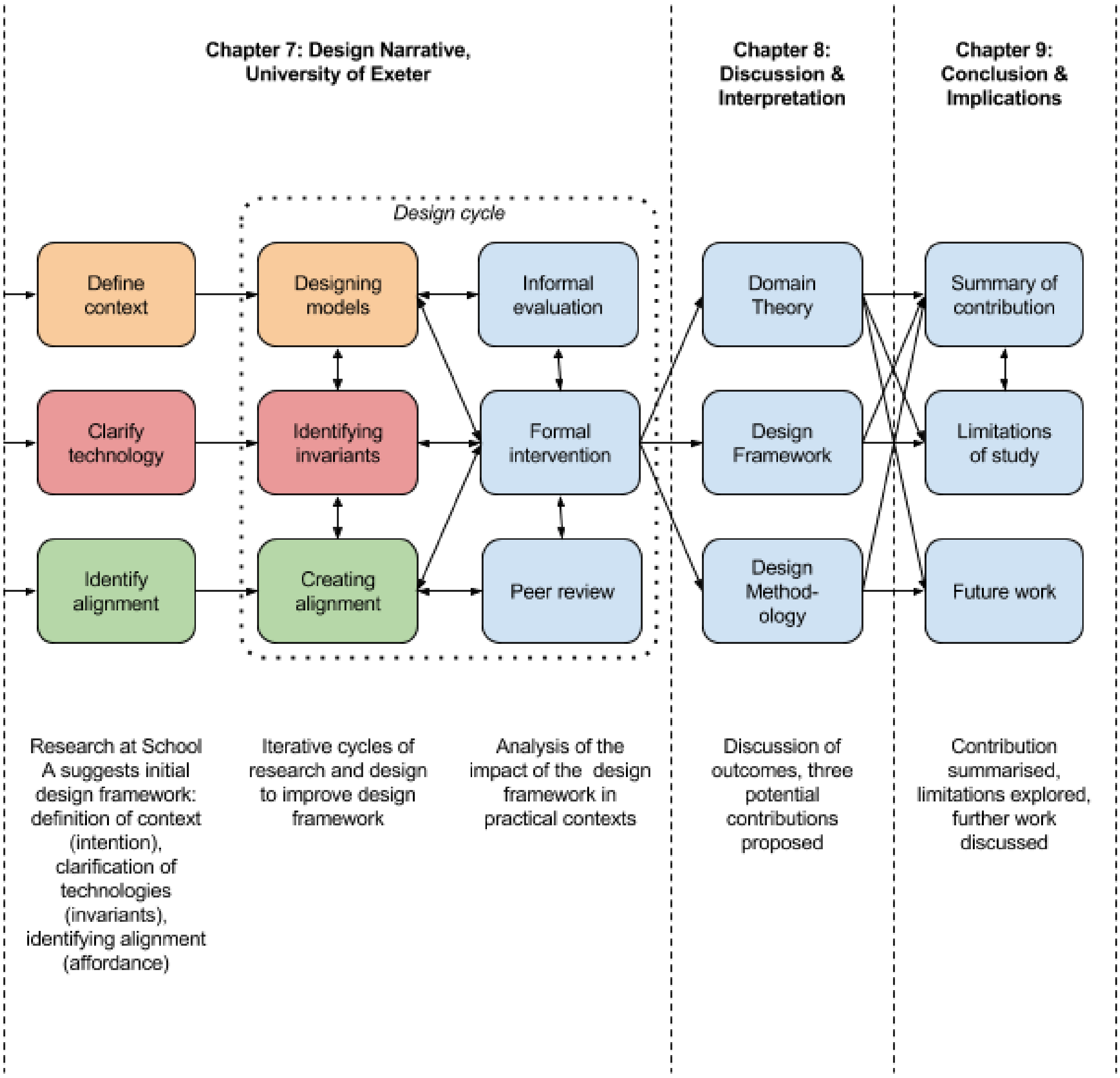
The theory of affordances has been used extensively within many fields, including educational technology, but remains a divisive and often under-defined term (Hammond, 2010). This thesis argues that this may in part be due to its distortion through adoption in multiple disciplines, and its popular description as the ‘action possibilities’ presented by an object or scenario, something not present in the theory’s original conception. It is suggested that a return to the original theory of affordances as proposed by Gibson (1979), which attempted to explain how individuals derive meaning from the world around them, returns clarity to the theory. A particular focus on the underexplored aspects of intention and invariant, together with a re-appreciation of what it means to apply the theory of affordances to digital environments, to digital spaces and places, provides a way of thinking about affordance that arguably can be applied more constructively to the effective use of technology in education.

A design-based research approach was taken in order to research the original concept of affordance, and its key components of intention and invariant, within learning scenarios supported by digital technologies. Design-based research is an evolving methodology, with no strict definition, but it has shown promise in both the design and the research of technology-enhanced learning environments (Wang and Hannafin, 2005). A pilot phase at secondary school level demonstrated the potential for the approach; multiple iterations at a higher education level developed and enriched these findings into a stable model for the alignment of digital technologies with a particular pedagogical scenario.

Findings suggest that affordances can be used to ‘explain’ educational technology, if the concept is broadened to include the wider ecology of learning; digital technologies not only as tools, but also as places. Extending the notion of affordances from ‘action possibilities’ to ‘transaction possibilities’ gives agency to both learner and technology, and recognises the important contribution of the digital environment to the learner experience. A specific design framework is offered which uses this redefinition of affordances as a design tool to align an authentic learning scenario with the digital technologies that have the potential to support that learning scenario. A generic design methodology is proposed, based on this framework, which has the potential to align pedagogy and technology using this updated definition of affordance. To close, some thoughts on the value of the design-based research approach are discussed.

Structure of Thesis




Chapter 7: Design Narrative, University of Exeter
Chapter 8: Discussion & Interpretation
Chapter 9: Conclusion & Implications
Design cycle
Define context
Designing models
Informal evaluation
Domain Theory
Summary of contribution
Clarify technology
Identifying invariants
Formal intervention
Design Framework
Limitations of study
Identify alignment
Creating alignment
Peer review
Design Method-ology
Future work
Research at School A suggests initial design framework: definition of context (intention), clarification of technologies (invariants), identifying alignment (affordance)
Iterative cycles of research and design to improve design framework
Analysis of the impact of the design framework in practical contexts
Discussion of outcomes, three potential contributions proposed
Contribution summarised, limitations explored, further work discussed

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Author’s declaration

Part of the work presented in this thesis has previously been published in a co-authored paper with colleagues at the University of Exeter:

Osborne, R., Dunne, E., and Farrand, P. (2013). Integrating technologies into “authentic” assessment design: an affordances approach. *Research in Learning Technology*, *21*(1), 1–18.

I hereby declare that I wrote the first and all subsequent drafts of this paper. I invited my co-authors to join me on the paper due to their previous experience publishing journal articles, but they advised purely on structural, typographical and grammatical issues.

Chapter 1: Introduction and Background to the Research

"Discontent is the first necessity of progress."

Thomas A. Edison

Beginnings

This thesis is the product of discontent. I hope it is also a sign of progress.

As a young web designer working for the first time in education in 2001, I was somewhat in awe of those whose expertise was in education. This was a novel and somewhat mystical field, with a language that although common enough in terms of the words I was hearing, was certainly not common to me in terms of the meaning of those words. This was a true community of practice that I was not a member of. As such I rarely considered that my own opinions on some specific pedagogic design choices were valid. Moving into education from the world of business was a shock, and although my background in psychology provided some grounding in how people learn, I struggled to understand this new community that I was now part of. I struggled in particular to understand why this community seemed to value so highly the potential of technology to transform education.

Technology was my bread and butter, I understood it better than anyone I knew, yet here I discovered a world where technology seemed to be seen as a panacea for education's ills, a way of transforming educational practice. But for all my personal expertise when it came to digital technologies, I couldn’t quite see the link. I couldn’t see why technology would provide the sort of transformation in education that was so commonly expected. The only sensible answer seemed to be to learn about education, about educational theory, and about the history of educational technology. The sensible path seemed to be to undertake the broadest and longest period of sustained study and research that I have ever attempted: a doctorate in educational technology. The result is this thesis. But before I begin to describe the research I undertook in order to better understand educational technology, let me first explain what prompted me to undertake this study.

The discussion forum phenomenon

During the many years I designed digital educational environments, I would often be asked to add discussion forums to websites. There seemed to be an unspoken belief that simply by adding a space for people to discuss, that would somehow cause people to come together and have educationally valuable conversations. I had this request many, many times, and watched these discussion forums fail again, and again. It was something I began to refer to as “the discussion forum phenomenon”. Many different types of forums were attempted, in different contexts and with different audiences, but very little discussion, if any, ever took place. It occurred to me that this insistence of including a discussion forum was akin to building a physical debating chamber in the real world, and then simply expecting people to turn up and start discussing. Without a need to discuss, and given the constraints of the digital world in terms of engaging with others, it was perhaps not surprising that these attempts tended to fail. According to Mason it seems that this problem is very much alive and well today, as they tactfully summarise “student participation in forums is rarely as complete as one would hope” (Mason, 2011, p. 1).

In the meantime my understanding of what websites actually were was changing, or perhaps to use a more accurate term it was evolving. I had started to think of websites not as online catalogues, newspapers, or brochures, but as spaces, individual places even, to be within, move throughout, to experience. Inspired by ideas such as the concept of information foraging theory (Pirolli, 1995), I developed a new way of thinking about what it means to create digital content that led me to break away from design that focused on hierarchy and formal structure, and start to create 'fuzzy' digital spaces that could reform and realign themselves to an individual visitors journey. I began to find new ways of creating experiences that only the digital world could provide, where the technology took agency itself according to how the visitor moved within the digital place.

What was prompting this thinking was a growing understanding of the layers of digital design, how code gave rise to place, and how to build and create experiences. An early example of this way in which code and design are transformed into experience, and the way this changed my thinking, is outlined for a website I created back in 2004.

"There are no tabs"

EVE stands for Everyone's Virtual Exhibition. It is a website that I designed in 2004, as a way of showcasing the collection of a local museum. This museum has thousands of artefacts, but like many museums has little physical space to show them, so the web provides a method for simulating these objects, together with a space to order them so they can be shared with digital visitors, whether near or far. An image showing the homepage of the EVE website can be seen in Figure 1.1.

Figure 1.1: The EVE homepage

The 'Eve Question' was something that occurred to me looking at the interface of that website. There are three distinct panels looking at Eve, a thin left one, a thin right one and a thick central one, the 'core' panel in the middle. This core panel is further divided by four tabs, allowing you to access different areas, and what in effect feels like four distinct places within the website.

The reality is there are no distinct places of the website as such. Any notion of moving from one space to another within the website, such as from the 'Your Collections' tab to the 'Exhibitions' tab, is entirely generated by the user interface. There could equally well have been more or less tabs and panels, and therefore people would find themselves in different digital places as a result. The code that generates the website is ‘spatially agnostic’, the different programming components that come together to generate any one tab could reside themselves in a myriad of different digital places, yet the interface as experienced presents them as a single entity.

The point is – “There are no tabs”, there are only links between content. The interface or surface of that content has been designed to suggest digital place. When creating a digital place, your aim as a designer is to create in the user a sense of a real place, using metaphors from the real world - here the sort of tabs that you might find within a filing cabinet or portfolio - to suggest distinct places within the overall space. The layering that is a constant, or invariant, feature of all websites allows the user interface to be effectively ‘turned off’. If the graphical elements are disabled in this manner, the design breaks back down to links. The tabs are an artefact, a visual “trick”, used to steer the user and create an experience of place within what is, in principle at least, a shapeless digital space.

Entrances and exits

Another realisation that came to me through my work as a web designer was that the experiences I was building for digital visitors to museums were qualitatively different to those experienced by real world visitors. More than that, they were impossibility different. Certain characteristics of the digital world, what I might now term invariants, were leading to quite different possible experiences, or what I might now term affordances. As I have already touched upon, museums typically have many exhibits that they are unable to share with their visitors due to restrictions on physical space. As the digital space is an unbounded space, there is practically no limit to the number of artefacts that can be digitised and shared with visitors using digital places, hence museums are often keen to exploit what the digital world might offer or provide in terms of new spaces.

This brings me to a peculiar phenomenon that I have often used to try and clarify why designing for the digital world differs from the designing for the real world - the fact that there is no main entrance, and no main exit. Or, perhaps to be more accurate, everything in the digital world can be an entrance and everything in the digital world can be an exit. This phenomenon is shown visually in Figure 1.2.

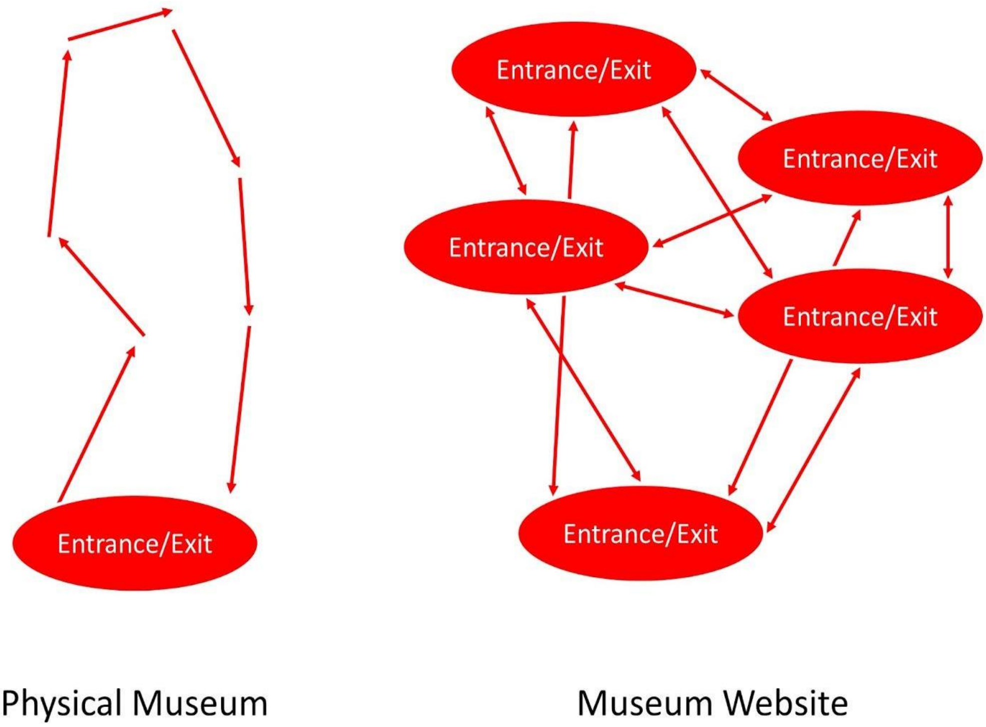


Figure 1.2: Entrances/exits in the physical world compared to the digital world

The local museum in Exeter, the Royal Albert Memorial Museum (affectionately known as the RAMM), serves as a useful example of this phenomenon in practice. This has two entrances for the public, which simultaneously act as the two exits as well. Once you've passed through these entrances, your experience of the museum will be largely dictated by the physical paths that are available to you by your choice of entrance, and the physical layout of the museum. You will never, for example, experience the world cultures collection without first experiencing a number of other collections. Navigating the physical world of the museum is an embodied experience, and as such it is limited by the physical constraints of the human body. We have a certain size and shape, a certain weight and height, which dictates where we can go and where we will fit. We are also subject to the natural laws of the physical world, such as gravity, climate, etc., that mean we stick to the earth, fall off things if we jump, and drown if we immerse ourselves in water. All these experiences are simultaneously constrained by time, they happen in and across time and are separated from each other by it. We have to jump off the cliff before we can drown in the lake; we can’t do both at the same time.

Navigating the digital world is not so clear cut. It is a disembodied experience, one that only a subset of our perceptual faculties can engage in, with that subset dependent on the type of physical computer hardware that is used. The hyperlink, the mainstay of navigating this digital world, provides immediate movement from one place to another place, a form of teleportation of the senses if you will. In the real world if you want to move from one place to another place, the only way to do this is by passing through all the places in between these two places. In the digital world I can simply jump from place to place, and skip all the intermediate places. I can do something ‘impossible’. Hennessy and O'Shea (1993) have likened this ability to do the impossible as a form of magic, something only possible when experiencing digital spaces.

The RAMM has many websites that showcase different collections, and different parts of collections, in different ways. Although these many websites may have homepages, which to some might suggest an entrance, in reality it is possible to enter any of these websites at any point, and similarly it is possible to leave at any point. This can be demonstrated by examining the underlying analytics data that monitors visitor activity. Data gathered by the author in 2005 showed that only 1% of digital visitors to the museum entered through the main website homepage, and only 15% of visitors entered through the homepages of the individual collections websites. 84% of digital visitors were simply arriving somewhere in the middle of the vast swathe of webpages within all the collections websites. Digital visitors tend to move to individual pieces of content directly, through search engine links, recommendations from friends, image searches, etc. and not through the more traditional entrances and exits. On the web, teleportation is so commonplace it is not even recognised. It is as if time and space is compressed within this new medium, so that movement between different places seems instantaneous.

It occurred to me that this new way of thinking about websites as spaces and places provided a framework to think about digital technologies that might help to identify how they might be used, and perhaps why they might fail. By thinking about the discussion forum as a distinct *place* for discussion, it became easier to see why people were not moving to this place and engaging in debate. The discussion forum phenomenon, the tabs issue, different entrances and exits, all these and similar issues provoked other thinking, that perhaps these new spaces and places were doing something different that wasn't possible in the real world. The digital debating chamber did seem to provide something unexpected, as a young undergraduate student put it to me one day, you can't interrupt someone in an online discussion forum.

> "The feeling of having a voice that no one can interrupt is a very powerful ego boost!"
>
> First year BA Education Studies undergraduate

Digital places seemed to have some invariant characteristics which were not present within real places, and this was creating some unusual opportunities for experience.

Viewport or screen?

The phrase "screen time" now has a dictionary definition. Oxford dictionaries calls it "Time spent using a device such as a computer, television, or games console". But this way of thinking about digital technologies is challenged by the concept of digital places. True enough the way we connect to digital technologies is predominantly through screens, though we can engage a range of perceptual faculties, e.g. hearing or touch, these tend to be secondary to vision and the screen is the preferred method of using digital technologies.

It is perhaps worth thinking about the word screen in this context, and what it means to use this word to describe the way we connect to digital spaces. According to Wiktionary the origin of the word screen comes from various European sources, including Middle English, Anglo-Norman and Old French, and originally conveyed a sense of protection as well as a sense of division. It is a word that separates, but it also describes a physical barrier between two different places. In this context the screen might be seen as the divisor between the real environment and a separate but distinct digital environment. The word viewport is perhaps an interesting parallel to the word screen. A screen is something to be looked on, it is an opaque surface that blocks. A viewport is something to be looked through, it is a clear surface that allows us to perceive content on the far side, perhaps a sea when on a ship, the clouds when on a plane - or even our planet, through the viewports of a spacecraft. When thinking about digital technologies and spaces and places, it is perhaps more useful to think of our computer screens as viewports, portals that allow us to view different spaces and places. “Screen time” focuses on the screen and how long it is engaged for, whereas viewport focuses on the place which the screen connects you to. This might seem obvious when exploring the affordances of digitally created 3D environments, such as the work by Dalgarno and Lee (2010), but perhaps less so when considering the everyday Virtual Learning Environments of Moodle and Blackboard.

Relationship to education

These emerging notions of websites, and perhaps all digital technologies, as providing digital spaces and places seemed like a useful and powerful way of thinking about technologies, and perhaps particularly for the field of education. The work building large websites suggested that the unbounded nature of digital space might be a powerful place to explore and test novel ideas, in a place that could ignore the constraints of the real world. Other work with museums suggested the opportunity to move immediately from specific place to specific place, in what might be described as digital teleportation, might be useful in bringing relevant content into thinking at the time when it could be most beneficial. The ability to speak uninterrupted, using the constraints of the digital interface as form of personal ego boost, seemed to change the learning dynamic, altering the way in which individuals interacted. All these ideas seemed to suggest that the environment that digital technologies provided had unusual characteristics that might be useful in educational contexts. Hence I began my doctoral journey looking for theories of experience which would allow me to join up ideas of space with meaning, of place with value. This led me to James Gibson's "Theory of Affordances" (Gibson, 1979), and the ecological approach to educational technology which runs throughout this thesis.

Objective of the thesis

The objective of this thesis is to explore the nature of technology, using concepts of digital space and digital place. It aims to study how people move through and interact in these places, how they make meaning from and within these places, and how this might impact learning. It uses Gibson's theory of affordances to provide a theoretical framework which structures and informs this exploration; in particular it uses the three components of intention, invariant and the 'space of possibilities' that link these two which are affordances themselves, in order to frame thinking. It is an attempt to look beyond the screen that divides the real environment and the digital environment, and explore the space and place beyond that exists there.

Gibson contested that laboratory experiments would never solve the problems of perception, as by preventing individuals from moving through their environment in natural ways these laboratory experiments could only ever provide a partial explanation of experience. Similarly in the present work, real life learning scenarios have been studied, adapted and evaluated in iterative cycles in order to try and tease out the relationship between affordances, digital space and pedagogy. A design-based research approach has been taken, an approach ideally suited to the exploration and iterative development of ideas in active teaching and learning scenarios over an extended period of time. Through this approach this research has the following overall goals:

- To clarify conceptions of digital space and place, in relation to existing theories, in particular theories that explore concepts of environment
- To explore invariant aspects of digital space and place, and what consequent affordances might be made available as a result of these invariants
- To understand how potential affordances might be designed into learning scenarios, and the impact of this on learners

Structure of the thesis

Chapter 1: Introduction and Background to the Research

Chapter 1 has outlined the personal background to the research, and the reason it was undertaken. It also provides a broad objective, and details the logical structure of the thesis as a whole.

Chapter 2: Technology and Learning

Chapter 2 explores the broader area of educational technology research to date, and summarises the main thinking in this area, in particular the apparent mismatch between the amount of resources invested in educational technology with a seeming lack of impact on learning outcomes. It explores some propositions for future thinking in this area, and in particular the notion of affordances as proposed by James Gibson. It proposes that the theory of affordances, being part of a wider ecological approach, is well suited to exploring conceptions of digital space and place.

Chapter 3: The Theory of Affordances

Chapter 3 explores where the theory of affordances originated, how it has evolved and been taken up by multiple disciplines, and how it has been used and debated when discussing digital technologies in an educational context. It suggests that the strength of Gibson's original concept has been diluted through this take up in multiple disciplines, and that a return to his original thinking would be beneficial. In particular it suggests that the current interpretation of affordances as 'action possibilities' is an unhelpful reduction, and proposes that the two 'ends' of affordance, intention and invariant, are crucial concepts that need to be revisited and reinstated.

Chapter 4: The Digital Environment

Chapter 4 considers the specific context within which the theory of affordances was framed, that of an ecological approach to visual perception. It attempts to bring Gibson 'up to date' by exploring some of the deeper context to affordances theory when applied to technologies, and explores the implications of placing the theory of affordances in a digital environment, as opposed to the natural environment. Comparisons are made between the experiences of individuals in real environments with experiences of individuals in digital environments, and how the original context for affordances - that of medium, substance and surface, and of objects and places - is realised in these digital environments. It suggests that this relocation of affordances may give rise to affordances that have yet to be fully explored. Together with perspectives on situated learning this provides a theoretical framework for the research.

Chapter 5: Research Methodology and Design Overview

Chapter 5 begins by exploring methodological issues relevant to the research of educational technology. It explains the choice of design-based research, and documents the approach that was undertaken to explore affordances, invariants and intentions within digital environments. It briefly discusses the two phases of the research which took place: (a) an exploratory phase to study how the affordances of a specific digital technology could be discovered and used by learners in an active learning context, in order to provide an initial design framework, and (b) the development, iterative application and evaluation of this design framework in multiple scenarios in order to produce stable designed products.

Chapter 6: Design Narrative, School A

Chapter 6 documents the context, design choices and analysis of research carried out at School A. The aim of this exploratory phase of the research was to study how the affordances of a specific digital technology could be discovered and used by learners in an active learning context, in order to provide an initial design framework for further development. Using a design narrative approach, it describes the issues encountered during research sessions and the evolution of thinking as a result of observations and experiences.

Chapter 7: Design Narrative, University of Exeter

Building on the research at School A, Chapter 7 documents the research that was undertaken at the University of Exeter. It begins by describing the wider context that this research was embedded within, the Collaborate project, which was tasked with exploring how to align employability, assessment and technology. The main design narrative then describes the research and design of a thinking tool to define pedagogical context, in the form of a dimensions model of good practice. Research undertaken to identify suitable digital technologies that could be aligned with the model using an affordances approach is presented. Finally, it describes the analysis of data gathered through iterations using these tools and techniques in practice with participants.

Chapter 8: Discussion and Interpretation

Chapter 8 discusses and interprets findings from Chapter 6 and Chapter 7. Three contributions emerged from the research: (a) a new understanding of affordance which returns to Gibson's original concept, affordance as 'transaction possibilities'; (b) a design framework which allows the alignment of a specific educational context with the digital technologies that have the potential to support that context, and; (c) a design methodology extracted from the design framework which may allow for the generic alignment of pedagogy and digital technology. Some thoughts on the value of the design-based research approach are also offered.

Chapter 9: Conclusion and Implications

Chapter 9 draws out the main conclusions from the research, and explores what the value of the contributions might be to the wider educational technology community. It highlights potential weaknesses by exploring the limitations of the study, and proposes areas for future work.

Chapter 2: Technology and Learning

> *[The Internet is] "the first thing that humanity has built that humanity doesn't understand, the largest experiment in anarchy that we have ever had."*
>
> Eric Schmidt, CEO, Google (1997)

Introduction

This chapter explores how technology has been viewed historically with regards to teaching and learning, and the research that has been attempted in order to demonstrate digital technologies impact on teaching and learning. Reflecting on the lack of progress in harnessing technologies to improve learning outcomes, it explores suggestions that technology enhanced learning lacks a theoretical framework within which to align technology and learning. Potential theories are outlined, and in particular the theory of affordances is suggested as one of the most promising means by which alignment might be attempted.

The promise of technology

For many centuries, perhaps even millennia, new and emerging technologies have promised to create radical transformation in many disparate fields. There seems something mystical, perhaps even magical, about new technologies that excites people as to the possibilities they might offer - perhaps because as Arthur C Clarke put it so succinctly, "any sufficiently advanced technology is indistinguishable from magic" (Clarke, 1962). Whilst few would perhaps agree that the Internet is a 'magical' creation, our literature is full of amazing conceptions of how technology might change our societies: from utopian visions such as Aldous Huxley's "Brave New World", through Asimov's robots with their positronic brains that can think like us, to darker and more disturbing scenarios such as George Orwell's "1984".

The field of education, like many other fields, is certainly not immune to this enthusiasm and excitement, and educationalists have long wondered how new technology might transform teaching and learning. Whether Josiah Bumstead back in 1841 writing about the introduction of the black board:

> "The inventor or introducer of the system deserves to be ranked among the best contributors to learning and science, if not among the greatest benefactors of mankind."
>
> Bumstead (1841)

or Thomas Edison celebrating the invention of the motion picture:

> "Books will soon be obsolete in the public schools. Scholars will be instructed through the eye. It is possible to teach every branch of human knowledge with the motion picture. Our school system will be completely changed inside of ten years."
>
> Smith (1913)

The fascination with, and excitement about, the potential of technology to transform learning seems firmly fixed in the minds of those interested in the topic of education. In 1945 in was the turn of the radio when the director of a Cleveland radio station, William Levenson, suggested that radios should be integrated into the classroom alongside blackboards. In the 1960s TV was the focus, with governments from both John F. Kennedy and Lyndon Johnson investing in television infrastructure for education, for example through the Public Broadcasting Act of 1967.

> “It will give a wider and, I think, stronger voice to educational radio and television by providing new funds for broadcast facilities. It will launch a major study of television's use in the Nation's classrooms and their potential use throughout the world ... Television is still a young invention. But we have learned already that it has immense--even revolutionary--power to change, to change our lives.”
>
> Johnson (1967)

Johnson proposed that students in small colleges would be able to tap the resources of the greatest universities, scholars from one side of the US would be reading books from the other side, and famous teachers “could reach with ideas and inspirations into some far-off classroom, so that no child need be neglected”.

This excitement continues today, with schools full of Interactive Whiteboards and iPads, and MOOCs the supposed dawn of a new age of education. But for all this excitement, difficult questions are now being asked in the educational community about exactly what technology is doing for us. Excitement about technology in education has led to investment in technology, but not it seems necessarily improvement.

As the commentary to a recent Nesta report in the UK exploring this investment puts it, “something is going wrong” (Luckin et al, 2012).

A brief history of educational technology

The blackboard certainly did become a key educational tool and indeed still is a crucial tool in many parts of the world, perhaps because as Laurillard (2012a) has pointed out, it is one of only a very few technologies that have been specifically designed for education rather than being appropriated for it. On the other hand, whilst the motion picture has certainly been influential in education, Edison may perhaps have been a little over enthusiastic in its potential. Psychology researchers Hall and Cushing (1947) later tested his notion experimentally, hypothesising that learning delivered using film would deliver better learning outcomes than that delivered either through a traditional classroom setting or through a self-study model. In fact they found no difference between the three conditions. However this promise of technology, its potential for transforming education, does seem deep rooted.

The introduction of the computer seemed to breathe new life into this transformative belief, leading to the widespread introduction of computers into the classroom around the world. However this belief in transformative power has not been echoed in educational improvements. Bork (1995) summarises the investment and subsequent failure in his 1995 editorial for the Journal of Science Education and Technology, “Why Has the Computer Failed in Schools and Universities?”:

> “Although computers have been used in education now for over 30 years, there is little sign that the major problems of education are getting any better. It is in terms of the overall quality of education nationally and internationally that we must judge whether the computer has made a positive or negative contribution. On this basis the computer is clearly a failure.”

Bork (1995, p.1)

Cuban (2001) also investigated this problem in his turn of the century book “Oversold and Underused: Computers in the Classroom”, the purpose of which was to challenge:

> "the belief that if technology were introduced to the classroom, it would be used; and if it were used, it would transform schooling"

Cuban (2001, p.13)

He questioned why the huge investment in computers across the US seemed to have resulted in very little use of these computers within education, and indeed if they were used why they were used infrequently and in unimaginative ways, given the fact that most teachers were frequent users of technology outside their classrooms. The huge investment in computers had not done anything to transform learning, as was expected. He remains a convinced sceptic about their transformative power, arguing that the hype often associated with them, together with a frequent level of immaturity in development and high costs, make them a seductive but difficult choice for educators Cuban (2012), and that more effort should be spent on understanding the role of education and technology in a sociocultural context.

This tendency to imbue technology with potentially transformative power continues into the 21st Century with Information and Communication Technology, or ‘ICT’ as it is more commonly known - an incredibly broad term that summarises technologies that can range from the World Wide Web to an iPad, from Microsoft Word to Twitter. However once again research has struggled to demonstrate any transformation in learning, for example Mee (2007) writes:

> “A concerted programme of e-learning focused school initiatives, well-funded and carefully targeted at measurable outcomes has led to increased availability of technology in schools ... All of the above has led to what could at best be described as incremental accommodation of educational technologies within existing organizational frameworks ... rather than the predicted 'transformation'”.
>
> Mee (2007, p.6)

In the United Kingdom the Higher Education Academy publication “Transforming Higher Education through Technology Enhanced Learning” by Mayes et al (2009) is perhaps a good example of this continuing widespread belief in ICTs transformative power, even given its long history of not living up to expectations, and this theme of transformation is echoed in many other publications. The UK policy document “Harnessing Technology: Transforming Learning and Children's Services” (Laurillard, 2005), again echoes the belief that through “a more strategic approach to the future development of ICT in education, skills and children’s services ...we believe we can transform teaching, learning and help to improve outcomes for children and young people”. This belief is not limited to the United Kingdom - in the United States Collins and Halverson (2009), for example, write that “The world of education is currently undergoing a massive transformation as a result of the digital revolution”. In an even broader context the Unesco publication “Transforming Education: The Power of ICT Policies”, Kozma et al (2011) makes the bold claim that “In all regions of the world, the penetration of Information and Communication Technologies (ICT) in schools has led to a major transformation of the education landscape” yet that same report does go on to clarify that “there is no consensus as yet regarding the actual benefits of technology in ensuring quality learning”. In fact they conclude that whilst “the capabilities of ICT can be harnessed to bring about significant change – indeed, transformation – in educational practices and structures. This has yet to happen.” Kozma et al (2011, p.218).

Even the underlying and often implicit assumption that technology must *somehow* be able to enhance learning is now being questioned by some. Of the few meta-analyses that have been undertaken, the largest rigorous study of this type by Means et al (2009) for the US Department of Education did demonstrate a small positive effect for blended learning situations, but noted that in these blended learning situations there still existed other factors which could have improved learning outcomes independently, e.g. increased learning time, different materials, and enhanced opportunities for collaboration. In addition there is an underlying methodological problem, in that those courses chosen for blended learning delivery may be inherently better suited for this mode of learning, leading to them being selected in the first place - effectively that positive results are due to sampling bias.

> "Despite what appears to be strong support for blended learning applications, the studies in this meta-analysis do not demonstrate that online learning is superior as a medium. In many of the studies showing an advantage for blended learning, the online and classroom conditions differed in terms of time spent, curriculum and pedagogy. It was the combination of elements in the treatment conditions (which were likely to have included additional learning time and materials as well as additional opportunities for collaboration) that produced the observed learning advantages. At the same time, one should note that online learning is much more conducive to the expansion of learning time than is face-to-face instruction."
>
> Means et al (2009, p. xviii)

Higgins, Xiao and Katsipataki (2012b) reviewed the work of Means et al (2009) amongst a wider review of 48 other meta-analyses, and similarly concluded that although small positive effects seemed to be associated with the use of technology, this could not be interpreted as causal. It was likely that more effective schools and teachers were simply using technology more effectively to support learning. Their analysis of research findings from experimental and quasi-experimental designs also suggested that in some cases technology was *not* as effective as other forms of educational intervention. They concluded that it was the manner in which the technology was used that mattered, not the technology itself; that the technology merely acted as a "catalyst for change".

> "The range of impact identified in these studies suggests that it is not whether technology is used (or not) which makes the difference, but how well the technology is used to support teaching and learning. This alignment of technology and learning is important."

Higgins, Xiao and Katsipataki (2012b, p. 15)

Similarly the ongoing data collection and interpretation of Russell's (1999) "No Significant Difference" phenomenon is struggling to demonstrate the transformative power of technologies. This long standing body of research into learning outcomes, which was originally between two different learning conditions - face-to-face and distant learning, seems to show that distance learning is equivalent to face-to-face from a learning perspective, hence the term 'no significant difference'. However, as the research in this area has continued, so the focus has shifted from face-to-face versus distant learning to 'media comparison study' or MCS research. This has now shown significant difference in some studies, but closer inspection by other researchers, (e.g. Clark, 1994; Spencer, 1999; Ramage, 2002) has suggested that there is simply too much variation between the various mediums and methods used in both cases to produce any categoric conclusion. An alternative interpretation of the research is that it shows that method is above everything else the key to a learner's success or failure, and that the medium through which a learner learns is irrelevant. Indeed, given that distance learning courses would necessarily be chosen for transition to a technologically mediated form specifically because they *could* be delivered in this way would suggest that they should, in turn, be better suited to that form and hence perform better - another example of sampling bias. The fact that they did not could perhaps be said to 'doubly damn' them.

A need for theory

This ongoing problem of the promise of technology coupled with its apparent failure to deliver does seem to be leading to a period of reflection within the wider field of education technology. There is perhaps something of an emerging acceptance that this promised transformation has not transpired, and indeed will not transpire, unless new approaches are taken that clarify exactly how technology might enhance education.

Different researchers propose different directions for future research to take in this area.

Laurillard (2012b) has suggested 5 reasons why education has made so little progress in getting the best out of technology:

1. The drivers of the education system - assessment, curriculum, inspection/ quality requirements, funding flows, promotion criteria – have not changed in recognition of what technology offers, so nothing within it can change.
2. Technological change is very rapid, and because every innovation is useful in education we need more time to make the radical changes they afford
3. The education system is run by leaders who are not comfortable with either the detail or the implications of the technology potential, and they need more support
4. Education is a political activity so avoids being subject to the innovation that market forces encourage
5. Education systems change slowly because they are hierarchical command-control systems, rather than devolved-power adaptive systems. Teachers and lecturers are given neither the power nor the means to improve the nature and quality of the teaching-learning process through technology

Laurillard proposes that addressing point 5 is the best way forward, by empowering teachers and lectures through extra support resources that illustrate how to take control of specific technologies for specific pedagogical challenges.

Bush and Mott (2009) argue that:

> “Educational reformers and academic technology strategists are waiting in vain for the promised revolution in teaching and learning because we have

> consistently, almost single-mindedly, used technology to automate the past instead of employing our best thinking and efforts to create a new future."
>
> Bush and Mott (2009, p.1)

They suggest that focusing on learner centric models that harness the malleable nature of technologies are the key, together with the 'network effect' that is possible through the high degree of connectivity offered by computer technologies.

Oliver (2013) has highlighted the lack of theory about technology itself, suggesting that it is this lack of a theoretical underpinning that is potentially holding back progress in understanding how technology can be utilised to enhance learning:

> "A significant gap in existing work within the field of educational technology - the failure to explain technology theoretically ... The consequence of this is that technology is treated as if it will cause learning - and when it does not, there is no clear explanation of why."
>
> Oliver (2013, p. 1)

Oliver goes on to suggest that there are two potential candidates for this theory:

> "To advance this discussion, two traditions of work theorising technology are introduced - one positivistic, including work on affordance, and the other (largely unrepresented in educational technology) that provides a social account."
>
> Oliver (2013, p. 1)

The potential role of affordance

The concept of affordance is not in widespread usage, so some attempt should be made to introduce it here. It was coined by the psychologist James Gibson who wanted to find a way of describing how individuals derived meaning from the world around them, what things ‘afforded’ them, but in a relational sense; as Gibson puts it to refer to “both the environment and the animal in a way that no existing term does.” (Gibson, 1979, p.127). It has proved a radical and powerful concept ever since, being taken up not only in psychology but also in the fields of design, human-computer interaction, educational technology and artificial intelligence.

Oliver (2013) clearly favours a new social account, though his juxtaposition of affordances and his social account as incompatible opposites is not without its problems, in as much as affordances are not themselves without a social component. Affordances will be more fully explored in the next chapter, but it is perhaps important to note here that recent neuropsychology research by Costantini and Sinigaglia (2011), has shown how affordances may be socially constructed, as observations of others performing actions seems to activate the same perceptual and motor areas of the cortex that would be activated if the individual was carrying out those self-same actions themselves:

> “What our experiments show is that the features of a situation may suggest or even demand a given action to us either directly, when they fall within our own peripersonal space, thus resulting to be ready to our own hands, or indirectly, when they fall within the peripersonal space of other individuals, thus resulting to be ready both to their own hands and through them also to our own hands.
> ...
> What is more, the fact that the affordance relation is not a private business of a single individual, but it relies on a mirror mechanism that allows one to share the space of her own action with others, highlights that the investigation of affordance mandatorily involves dealing with the cognitive processes underlying basic social cognition.”

Costantini and Sinigaglia (2011)

This research appears to show that affordances themselves may be socially constructed, that we seem to learn affordances through the observation of others, which would align them with the sociocultural learning theory associated with Vygotsky (1978), and suggests affordances may be worth exploring in more detail.

This is not the only instance where research many years after the theory of affordances was first published has validated its premise experimentally, the most widely known perhaps being the stair climbing research by Warren (1984) which attempted to 'prove' the theory experimentally, and it highlights the level of maturity of the theory itself which it seems can be easily missed by some researchers. Turner (2005) for example suggesting it is only a 'simple' concept, when in fact the theory of affordances was the culmination of decades of development by a prominent and well respected psychologist. The present work believes that the theory of affordances still has much to offer as a way of explaining the value of technologies to education, and that given the maturity and long standing value of the theory of affordances, the *potential* role of affordances for understanding how technologies can and should be used in learning contexts remains strong.

Although Oliver suggest that the work on affordance is overall unpromising, and indeed in an earlier paper (Oliver, 2005) he suggests that the theory of affordances has too many problems to be useful in an educational technology context, the idea of affordance is now deeply rooted in the field of educational technology, to such an extent that it is now frequently used without even clarification as to its meaning, e.g. Mayes et al (2009). For a term that originated in psychology, then moved to design, on from there to human-computer interaction, and finally through into educational technology, it has something of a chequered and therefore confusing path that has left it with many different interpretations, which as Oliver rightly points out can make the term analytically useless. However, as Hammond (2010) clarifies, there is perhaps a way forward:

> "If the concept of affordance is to be helpful, and if it is going to continue to be used, there must be greater agreement as to its meaning."
>
> Hammond (2010, p. 216)

Summary

This chapter has outlined a brief history of educational technology, and presented some thinking as to the lack of progress in harnessing digital technologies in order to improve learning outcomes. Potential ways forward have been discussed, including the use of the theory of affordances. The next chapter goes on to explore the theory of affordances in detail, where it came from, and how it has been adopted by different disciplines and factions over the years. It contrasts current and historical descriptions of affordances, and suggests that a return to Gibson's original ideas may help to provoke new thinking about the theory, which may in turn help to clarify its potential as a design tool for aligning pedagogy and technology.

Chapter 3: The Theory of Affordances

> *"Out of sight, out of mind."*
>
> 13th Century English idiomatic phrase

Introduction

The previous chapter has explored how technology has been viewed historically with regard to teaching and learning, and the research that has been attempted in order to demonstrate the value of digital technologies for teaching and learning. It proposed that the theory of affordances might provide a theoretical basis for aligning digital technologies with learning.

This chapter outlines the theory of affordances in detail, explaining its original conception, and how various factions have since both adopted it and adapted it for their own needs. It suggests that this adoption by multiple factions has distorted the original concept, and that current interpretations of affordance have diluted the concepts power. It proposes that a return to Gibson’s original ideas, together with a greater focus on the key components of intention and invariant, may help to restore the power of the affordances concept and clarify its potential for aligning pedagogy and technology.

What is Affordance? The original concept

The term affordance was defined in 1977 by the psychologist James Gibson, in his chapter “The Theory of Affordances”, part of a wider book edited by Shaw (1977) exploring ecological psychology. It was not the first time that Gibson had used the term, he originally coined the term in his 1966 book, “The Senses Considered as Perceptual Systems” (Gibson, 1966, p. 285) and it occurs in many of his earlier essays (e.g. Gibson, 1975), but this is the first time that he defines it explicitly:

> “What is meant by *an affordance?* A definition is in order, especially since the word is not to be found in any dictionary. Subject to revision, I suggest that *the affordance of anything is a specific combination of the properties of its substance and its surfaces taken with reference to an animal*.”
>
> Gibson (1977, p. 67) [his emphasis]

As he states in 1977, it is subject to revision, and indeed he does make slight adjustments to this definition in his seminal 1979 book, “An Ecological Approach to Visual Perception” (Gibson, 1979). In this definition Gibson clarifies that affordance exists in the *relationship* between the animal and the environment:

> “The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment.”
>
> Gibson (1979, p. 127)

Gibson had been exploring perception for most of his professional life, whether visual or in other forms, and had already begun to understand the animals perception of the world around it in a different form to that commonly understood. In his 1966 book, The Senses Considered as Perceptual Systems, Gibson outlined this in detail, describing how he believed the senses worked in an active way to ‘pickup’ information from the environment continuously. In his view, all the perceptual systems worked together holistically to provide the animal with a complete understanding of its state within its environment, ongoing over time and in relation to the sense of self or proprioception, rather than the view that discrete sense information for smell, touch, sight, etc. is then recombined internally by some computational process. The recombination view, prevalent in scientific and philosophical studies of perception for hundreds of years according to Reed (1989), was in the 1950s becoming couched in the terms of the computer, of input and output, of computation and storage.

Gibson was writing at a time when two different theories of learning were prevalent, behaviourist theories that emphasised stimulus-response as epitomised by the work of B F Skinner, and the theories of Cognitivism based on Gestalt psychology. Gibson's work followed in the Gestalt tradition, in that it viewed the individual in more holistic terms as part of their environment, but it had a crucial difference from cognitivism in that it eschewed internal mental representations of the visual world that an animal experienced.

A common understanding at the time of how visual perception worked was that an image projected onto the retina was somehow decoded and processed by internal mechanisms within the brain and hence that image was translated into meaning for the animal in question. This view of perception is widely recognised though to have a fundamental flaw, in as much as it creates a 'homunculus problem', which Gibson himself explains later in the book:

> "It leads to one of the most seductive fallacies in the history of psychology - that the retinal image is something to be seen. I call this the 'little man in the brain' theory of the retinal image, which conceives the eye as a camera at the end of a nerve cable that transmits the image to the brain. Then there has to be a little man, a homunculus, seated in the brain who looks at this physiological image. The little man would have to have an eye to see it with, of course, a little eye with a little retinal image connected to a little brain, and so we have explained

> nothing by this theory. We are in fact worse off than before, since we are confronted with the paradox of an infinite series of little men, each within the other and each looking at the brain of the next bigger man."
>
> Gibson (1979, p.60)

Gibson's ecological theory of visual perception removed the need for this internal processing, as it suggested that the world was directly experienced as it happens in real time, and that information is simply 'picked up' as the animal moves about its environment. A full description of the ecological theory of visual perception is beyond the scope of the current work, but it should be understood that it caused fundamental debate within psychological circles at the time (Costall, 1984), and the concept of affordances in particular needs be understood as part of this ground breaking wider theory, with its purpose of explaining how animals make sense of the world around them. It has parallels with Vygotsky's thinking on perception and meaning, as Vygotsky also recognised that human perception is about meaning in the world, rather than properties in the world, what he termed "the perception of real objects":

> "I do not see the world simply in color and shape but also as a world with sense and meaning. I do not merely see something round and black with two hands; I see a clock and I can distinguish one hand from the other."
>
> Vygotsky (1978, p. 33)

Gibson's work implied "a new theory of meaning and a new way of bridging the gap between mind and matter" (Gibson, 1982, p.409). It will be argued later that the notion of meaning making, and the wider context of the theory in terms of medium, substance and surfaces of the environment, has an important bearing of the role of affordances from an educational technology perspective.

The key concept of affordance is that it exists in the *relationship* between the object that is perceived and the subject who is the perceiver, it does not exist exclusively in either the properties of the perceived or the perceiver, but only in the relationship between the two. Gibson always intended the concept of affordances to span the dichotomy of subject/object in a way which nothing else does.

> "An important fact about the affordances of the environment is that they are in a sense objective, real, and physical, unlike values and meanings, which are often supposed to be subjective, phenomenal, and mental. But, actually, an affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer."
>
> Gibson (1979, p.129)

A direct result of this conception is that any object only has affordances for a specific perceiver, and indeed the same object may hold different affordances for different observers, both in the same contexts and in different contexts. A classic example often used is that of a set of stairs. For an average human adult, stairs will afford stepping, but for a child or someone with impaired locomotion they may afford nothing at all, or indeed may offer a negative affordance as they may present a barrier to movement. The affordance is hence a product of the object/observer relationship.

Figure 3.1: A fence around a tree at a national trust property (from the author, 2013)

Figure 3.1 demonstrates this specificity of affordance in context. For a typical western adult, the barrier around the tree provides a message; it means “stay on your side of the fence please”, a request not to penetrate the barrier. It provides a socio-cultural affordance, the unbroken ring that will impede (though not stop) progress is a sign the meaning of which most people will understand. However, for a 3 year old child the barrier is a toy, a challenge, something to be inspected, ducked under, bounced over. They have not yet acquired sufficient socio-cultural awareness to pick-up the meaning, the affordance as picked-up by an adult is simply not there for them.

The structure of affordance

If the concept of an affordance should be understood as the relationship between the object that is perceived and the subject who is the perceiver, the question remains what precisely is it in both which might give rise to an affordance. What in the world, and what in the individual, might possibly combine in order to provide an affordance? Gibson provides an answer in the form of the roles played by invariants in the world and intention in the individual. Together these provide the ‘ends’ of the theoretical framework where affordance lies.

Invariants

A fundamental tenet of affordances theory is the notion of invariants. If affordances are the relationship between an individual and the environment, i.e. what something in or about the world offers or means to a specific individual, the concept of invariants relates to the specific nature of the world that is attended to which makes these affordances perceivable. Invariants underlie affordances, and ground them in the world that is perceived.

Invariants are not an invention of Gibson, and are widely used in fields such as computer science, mathematics and artificial intelligence. In all cases they refer to something that does not change over time. When a computer programme runs, or a mathematical calculation is performed, the invariants within that process remain fundamental to that process but are unchanged by it. A catalyst in chemistry might be considered an invariant in the same way, something fundamental to a chemical reaction, but unchanged by it.

Invariants in relation to the theory of affordances are often discussed as ‘invariant properties’ (e.g. Hammond, 2010), though the direct connection between these two terms is something that Gibson himself seems to avoid. From Gibson’s perspective, invariants are not perhaps simply the specific properties of an object or the wider environment; rather they are something that is *created by* the properties of the object in combination with the wider environment and the perspective of the observer. Take the shaft of a typical hand axe or hammer, it will most likely be made of wood, have a diameter roughly 2-3 cm, be approximately 30cm long and be relatively straight and smooth. This will create various types of invariant based on the substance and its form, the hardness of the word and its resistance to deformation, the manner in which light is reflected from the object both when it is static and when it is moved, the constancy of its span and breadth, i.e. the ratio between separate aspects of the axe. The invariants lie in the substances that make the object, and in the form that these are arranged. They are not perhaps so much properties of the object itself, but are to do with the components that make up that object. Note, though, that these are not *affordances*. An affordance exists for an adult of grasping, which in turn exists because of the combination of invariants, but for a small child that same affordance does not exist, even though the invariants have not changed. It is perhaps also worth noting in this example that although an affordance of grasping *exists*, that does not necessarily mean that it is attended to. Intention defines whether an affordance is perceived; intention will be discussed in more detail shortly.

A classic example of invariance is the gradient that some surfaces project as they are viewed disappearing into the distance, as demonstrated in Figure 3.2. This perhaps better demonstrates how invariance can be produced by the properties of objects in relation to the environment, i.e. it is in the combined perception of the objects that some specific invariance emerges.

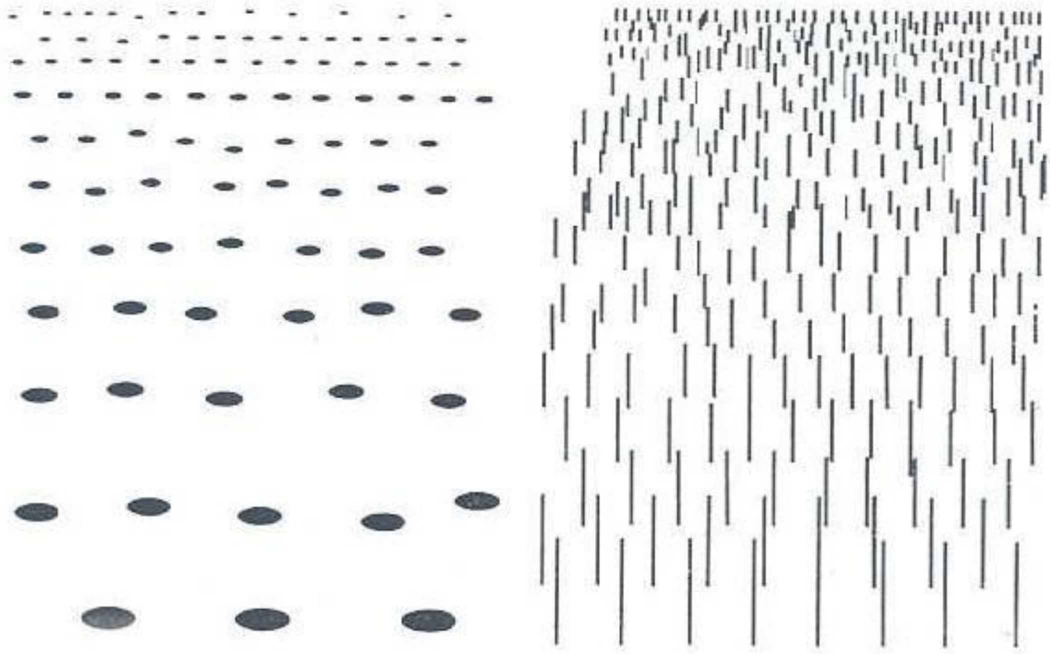


Figure 3.2: The invariance present in a gradient (from Gibson, 1950)

The invariance in Figure 3.2 is the consistency in the pattern, which provides us with a sense of depth. From an affordances perspective this suggests that that there is a space we can walk into and through. A real world example of these two texture gradients is illustrated in Figure 3.3. A real observer situated in the cut field of bales in Figure 3.3 would notice two things that are critical from an invariant perspective, that: (a) the invariant effect is maintained across multiple visual angles and is consistent as the observer moves around the field and; (b) that the invariant effect is reversible, retracing your steps across the field does not change the effect, the invariance is permanent. There is no specific property of an object that can be extracted which creates the overall invariant effect that is demonstrated, it is the position of objects within the wider environment combined with their individual shape, texture, colour etc. that creates the invariant effect.

Figure 3.3: Real world examples of texture gradient (from the author, 2007)

The concept of invariants will be revisited in Chapter 4, in the context of digital environments, but it is included here as an understanding of the role of invariants is seen as fundamental to an understanding of the theory of affordances. Invariants are simple enough concepts to understand in the real world, as they surround us and can easily be tested and explored, but it will be argued that they can be particularly challenging in a digital environment, where the normal ‘rules’ of the real world are easily broken, breaking down the invariant effect and hence breaking down affordances.

Intention

The second aspect of affordances that is fundamental to understanding the concept is the notion of intention. Affordances have already been discussed in terms of their personal and relational nature, that they exist between the environment and a specific individual. However it is also true that generic affordances may exist, because animals - and humans as part of the animal kingdom - have generic traits, and hence we can identify generic affordances. An average grown human, whether 7 or 70, should be able to climb a set of stairs, for example, the stairs could be said to afford climbing. What this simple example lacks, however, is whether or not the individual in question actually *wants* to climb stairs - what they *intend*. As Heft (1989) clarifies:

> "... an affordance is perceived in relation to some *intentional* act, not only in relation to the body's physical dimensions."
>
> Heft (1989, p. 13) [my emphasis]

Humans exist within a busy environment. A quick glance around any physical space - such as the one the reader is currently located within - should reveal many, many articles and objects within that place, many nooks and crannies, perhaps even other individuals. Consequently, the reader is also surrounded by many, many affordances, thousands at any one time. Floors that could be crossed, windows that could be looked through, or opened and climbed through, books to pick up, to throw, to read, to rip, perhaps other individuals, to be engaged in conversation, observed, discussed, etc.. However, we do not attend to these affordances, because we have no need at this point in time, we have no *intention* that would be served by engaging with these affordances. As Gibson puts it,

> "Needs control the perception of affordances (selective attention) and also initiate acts."
>
> Gibson (1982, p.411)

Without this concept of intention or need, affordances become a theoretical categorisation tool, rather than a practical design tool. To attend to every possible affordances at every possible moment would be impossible, instead we selectively attend to those affordances which are relevant to us according to our needs at that specific moment in time. Affordances are stable, they do not change as our needs change. As Gibson again clarifies:

> "The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived."
>
> Gibson (1979, p. 139)

This concludes the overview of the original theory of affordances from Gibson, and its key components of invariant and intention. This chapter will now briefly explore how affordances have been taken up by, developed, and adapted by different disciplines, and summarise how these different disciplines now conceive affordances.

Evolution of the concept

Affordance was originally coined in a psychological context, and has become a founding tenet for the field of ecological psychology. According to Jenkins the theory of affordances was a pivotal concept, "genuinely and quite literally radical" at the time, Jenkins (2008, p. 39). As with all radical things, it has tended to both stimulate and polarise debate from its early days. Neisser (1977), for example, recognised the radical nature of the theory, and recognised its overall validity, but argued that it did not sufficiently explain active perception. He contested that separate internal schemata were involved, multi-use mental models that can be applied in different scenarios. Hamlyn (1977) was also largely receptive to Gibson's idea, but similarly considered Gibson's theories incomplete as they did not include internal mental processing. Gibson argued in contrast that "knowledge of the world cannot be explained by supposing that knowledge of the world already exists" (Gibson, 1979, p. 253), effectively suggesting that arguments in support of mental processing were simply extensions of the homunculus problem.

The term affordance has remained powerful and popular through many years of ecological psychology research, and has been debated many times within that professional community (e.g. Ginsburg, 1990; Turvey, 1992; Greeno, 1994; Jones, 2003; Stoffregen, 2003; Chemero, 2003; Turvey, 2012). Within ecological psychology the term is now loosely agreed to refer to a perception-action cycle, and the possibilities for action that an individual may choose from within a specific context.

The term has also been adopted by the design community, and in particular the human-computer interaction community, as a result of Don Norman's appropriation of the term in his book "The Design of Everyday Things" (Norman, 1988). This community has also debated and developed the term (e.g. Gaver, 1991; Norman, 1999; Baerentsen, 2000; McGrenere and Ho, 2000; Albrechtsen, 2001; Hartson, 2003; Torenvliet, 2003; Caiani, 2014). Within the design / HCI community the term is broadly agreed to refer to the action possibilities that a design element might suggest to a user of the designed object. There is more emphasis on the perceived affordance of objects (Norman, 1999) and the possibility of false affordance (Gaver, 1991).

A third field that has adopted the term to some extent is that of cognitive science (e.g. Salomon, 1993; Zhang, 2006), where it is seen as a potentially useful explanatory term for understanding distributed cognition. Zhang (2006) in particular has created a framework within which constraints and affordances can be aligned to visually summarise how cognition is distributed across individuals and the environment, and how this can be used to reveal a subset of possible actions as a result.

Most relevant to the current work is how the term affordance has been appropriated within the educational technology community. It is perhaps unclear exactly how the term became so common within this community, though it appears that it was prevalent as early as 2000, as Laurillard notes:

> "'Affordances' is a word now in common currency in describing characteristics

of the learning process."

Laurillard et al (2000)

The term has been widely debated within educational technology contexts (e.g. Greeno, 1998; Kennewell, 2001; Conole and Dyke, 2004; Boyle and Cook, 2004; Barab and Roth, 2006; Wijekumar et al, 2006; Freidhoff, 2008; Hammond, 2010; Overdijk et al, 2012), but remains of disputed usefulness (e.g. Oliver, 2005; Derry, 2007). Various approaches have been taken to trying to identify the value of technologies within learning contexts using affordances, most commonly to outline categories or types of affordances. For example:

- Kirschner et al. (2002) suggests affordances should be considered as Educational, Social or Technological
- Hartson (2003) breaks affordances down into Cognitive, Physical, Perceptual and Functional
- Conole and Dyke (2004) chooses Accessibility, Speed of Change, Diversity, Communication and Collaboration, Reflection, Multimodal and Non-linear, Risk, Fragility and Uncertainty, Immediacy, Monopolisation and Surveillance
- Bower (2008) splits affordances into Media, Spatial, Temporal, Navigation, Emphasis, Synthesis, Access-control and Technical

The breadth and scale of potential affordances available within the world perhaps inevitably leads to the temptation to attempt to categorise and silo affordances, so that they might be broken down into manageable sections. However, it is an inherent problem with any attempt at categorisation that some objects will inevitably live in more than one category. Hartson (2003), for example, attempts to improve understanding of the affordances concept in his work, but arguably introduces more confusion than clarification. There is implicit within his categorisation of affordances, as broken down in Table 3.1 below, an ontological perspective which separates out our ability to sense, think and act. It supports an information processing model of behaviour which is in direct tension with Gibson's ecological model, where perception is directly tied to meaning through the idea of 'information pick-up'.

Affordance type	Description	Example
Cognitive affordance	Design feature that helps users in knowing something	A button label that helps users know what will happen if they click on it
Physical affordance	Design feature that helps users in doing a physical action in the interface	A button that is large enough so that users can click on it accurately
Sensory affordance	Design feature that helps users sense something (especially cognitive affordances and physical affordances)	A label font size large enough to read easily
Functional affordance	Design feature that helps users accomplish work (i.e., the usefulness of a system function)	The internal system ability to sort a series of numbers (invoked by users clicking on the Sort button)

Table 3.1: Summary of affordance types (Hartson, 2003, p. 323)

From a design perspective this breakdown looks tempting, as it suggests the design process can be itemised and regulated according to these types. In practice however the crossovers between these types are too strong and intertwined. From an ecological perspective it would be argued that individuals recognise an affordance in general; in practice we do not sense an affordance, and then think about an affordance, and then act on affordance.

A common theme throughout all these interpretations of affordances, however, remains the idea that affordances can be restated as 'possibilities for action'. Greeno, for example, summarises affordances as providing a "type of activity that is possible":

> "Affordances can be represented, using situation-theory notation, as if-then relations between types of situations, in which the antecedent involves resources in the environment and enabling characteristics of a person or group

> and the consequent is a type of activity that is possible whenever those environmental and personal properties are present."
>
> Greeno (1998, p.9)

There is no attempt here, however, to include the intention of the individual, only their 'enabling characteristics'. It is at its core a behaviourist definition which leaves little room for the will of the individual.

From a psychological perspective, and an ecological psychology perspective in particular, this appropriation of the term by different disciplines is problematic. As Turvey, a leading thinker within the ecological psychology community, reflects in a recent paper:

> "Especially bothersome is the co-opting of terms (e.g., affordance and optic flow) for uses in cognitive science, human factors, and education that are conceptually at some remove from their definitions and usage in ecological psychology."
>
> Turvey (2012, p.135)

Turvey argues that as each discipline tries to apply the concept of affordance to fit its own needs, so the term becomes ever more diluted. It is perhaps interesting to observe that in this paper Turvey also defines affordances in terms of action possibilities:

> "an affordance is an invariant combination of properties of surface and substance taken with reference to an organism and specific to an action performable by the organism."
>
> Turvey (2012, p.134)

The first part of this definition is pure Gibson, and is taken almost word for word from

Gibson himself (1977, p. 67). The last section though is a new addition to the definition that is now widespread, the idea that affordances must be tied to action. Widely credited to Gibson, this link with what has become known as action possibilities is nowhere to be found in Gibson's own writing, and is arguably incompatible with it. An example might help to clarify. Shortly after Gibson's own (1977) definition he goes on to give several examples of affordances, one of which states:

> "The events of the environment afford being frozen, as in a blizzard, or burned, as in a forest fire."
>
> Gibson (1977, p. 68)

These are not actions, and cannot be redescribed as 'action possibilities'. Being frozen or burnt are not, to use Turvey's words, actions performable by the organism. We can perceive these affordances, and indeed we can take action because of them, but from an affordances perspective they act on us, not the other way around.

Similarly in his original writing on affordances, Gibson describes how affordances might relate to what we think a person might provide for us, irrespective of any specific action, in a section where he discusses how people learn the affordances of objects:

> "He also learns what objects can be used as the means to obtain a goal, or to make other desirable objects, or to make people do what he wants them to do."
>
> Gibson (1966, p. 285)

In this context it is again difficult to see how affordances as 'action possibilities' is sustainable, if understanding how to influence other individuals could also be thought of as an affordance.

The term 'action possibilities', or the wider but arguably synonymous concept of 'possibilities for action', seems to have become intertwined with affordances in all disciplines that use the term. However a thorough examination of Gibson's original writings on affordance does not reveal any reference to this term, and indeed it is not present in Gibson's original definition. Human searches of the texts written by Gibson on affordance have been examined, and no trace of this description of 'action possibilities' can be found in them. In addition key texts, such as Gibson (1979), have been converted to digital formats, transformed into 'real' words using optical character recognition software, and scanned for relevant keywords such as action, possibilities, possibility, etc. using computer search algorithms. Again, no matches have been found.

Considering how widespread this association of action possibilities is with Gibson's conception of affordance, it is perhaps worth exploring how this term became so linked with affordance.

Affordances as 'action possibilities'

It does seem to be a commonly held understanding of Gibson's concept of affordances that it concerns the 'action possibilities' that are available to an individual which are provided by the environment. To quote perhaps the most common source that people turn to for clarification currently available, i.e. Wikipedia:

> "An affordance is a quality of an object, or an environment, which allows an individual to perform an action."
>
> (Wikipedia, http://en.wikipedia.org/wiki/Affordances, accessed 24th July 2012)

Whilst the reliability of Wikipedia may be questioned, it is certainly as scholarly as some more established references (Giles, 2005), and this reference to 'action possibilities' or the 'possibilities for action' does seem to be widespread in the educational literature on affordances, and in the wider ecological psychology literature.

Oliver (2005), for example, states that it was these very “possibilities for action ‘afforded’ by technology that prompted interest in the term” whilst Hammond (2010) similarly concludes that “affordance offers a distinctive perspective on the use of ICT in education because of its focus on possibilities for action”. Kirlik (2004) explicitly states that it is the very notion of an “opportunity for action” inherent in the affordance concept which accounts for its “scientific utility”. Conole and Dyke (2004), quoting Salomon (1993), don’t quite use the term action possibilities, but the definition used also takes an action or utility based approach:

> “‘Affordance’ refers to the perceived and actual properties of a thing, primarily those functional properties that determine just how the thing could possibly be used.”
>
> Conole and Dyke (2004, p. 115) quoting Salomon (1993, p. 51)

Although this definition is claimed to be from Gibson, a closer inspection reveals that this text is actually taken directly from Norman (1988, p. 9), and not Gibson at all.

Throughout the literature on affordances, it seems that Gibson’s original concept is repeatedly and pervasively confused with the later work by Norman, and commonly re-defined solely in terms of action possibilities. A computer based search of Gibson’s actual text from the Ecological Theory of Visual Perception reveals that the concept of ‘action possibilities’ or ‘possibilities for action’ is never actually mentioned. In fact the only reference to actions and possibilities together by Gibson seem to be in his 1950 work “The perception of the visual world”, Gibson (1950), and this is not linked to affordance, as the term had yet to be coined by him.

An examination of the literature in this area suggests that the term ‘action possibilities’ was most probably first coined by Heft (1989), an ecological psychologist (Ginsburg, 1990). Heft was a strong supporter of Gibson, and intended to strengthen the applicability of affordances specifically within socio-cultural contexts. This linking of affordances and actions appears to have been further embedded by Donald Norman's student, Bill Gaver, in his key work which attempted for the first time to try to comprehensively understand the role of affordances when considered with regards to technologies, "Technology Affordances" (Gaver, 1991). As a designer, and an interaction designer at that, Gaver was interested in how affordances might be used to help design objects for use. The continuing association of 'action possibilities' with affordances seems to have been cemented by McGrenere and Ho's (2000) article "Affordances: Clarifying and Evolving a Concept", which explores the concept from a Human Computer Interaction (HCI) perspective. Whilst McGrenere and Ho provide thought provoking expansions to the original concept of affordance, and lay the foundations for the 'explosion' of Norman's original use of the term into the separate HCI concepts of affordance and visibility, they still associate Gibson firmly with the notion of action possibilities.

> "The most fundamental difference between the two definitions is that for Gibson an affordance is the action possibility itself whereas according to Norman's use it has been both the action possibility and the way that that action possibility is conveyed or made visible to the actor."
>
> McGrenere and Ho (2000, p.3)

However as has already been discussed, this idea that action possibilities was present in Gibson's original theory does appear to be incorrect.

Implications of 'action possibilities'

Having explored how 'action possibilities' has become associated with the concept of affordances, it is perhaps important to ask the question what impact this might have on the use of the term. Reforming a concept over time is not necessarily negative, and is often a necessary and important aspect of intellectual endeavour (Kuhn, 2012). If, however, a misconception has taken place at some stage in that reform, leading to the term becoming confusing and divisive, it is perhaps worth returning to original conceptions of affordances.

The history of the use of the term affordance in educational technology would suggest that we have reached such a position. Papers summarising discussions in this area, for example papers such as Oliver's (2005) "The Problem with Affordance" and his (2013) paper, "Learning Technologies: Theorising the tools we study" do suggest that the term has become so problematic as to be analytically useless.

> "This article reviews the concept of 'affordance' ... it is argued that the concept has drifted so far from its origins that it is now too ambiguous to be analytically valuable."
>
> Oliver (2005, p.1)

In order to explore how an 'action possibilities' approach to affordance might be contrasted with Gibson's original ideas, and the implications of this, a number of illustrative examples are presented below. These attempt to highlight the weakness of an action possibilities approach when compared with Gibson's original conception of affordance.

Affordance of a clock

A simple explanation of the affordance of a clock from an action possibility perspective would be that a clock affords reading the time. As Heft (1989) points out though, affordances are situated, they exist in a specific context. If we add context to this example, perhaps a student in an exam checking his watch or a clock on the wall of the examination room, then we arrive at a much more complex and arguably valuable explanation for the clock's affordance. In this *situated* example the clock affords knowledge of how much time the student has left to finish his work. The current time is largely irrelevant, taken from the students perspective all that matters is how many minutes he has left to work, and hence this is the affordance that the clock provides or furnishes. The static and detached affordance aligned to action possibilities of 'what time is it' is replaced by a dynamic and consequential affordance of 'how much time do I have left'. The affordance is situated in a specific place and time, and the current state of both the environment and the individual specify the affordance that is currently applicable from the range of potential affordances that might apply.

Heft (1989) clarifies that the problem that Gibson was addressing with the theory of affordances was that of meaning:

> "With this concept Gibson offers a new approach to a knotty problem in perception theory; namely, the problem of accounting for meaning in perceptual experience."
>
> Heft (1989, p.1)

Affordances are about the meaning that is provided by the environment with respect to a specific individual and their intentions at a specific moment in time. Reducing them to action possibilities distracts from what is arguably the most valuable aspect they offer from an educational perspective, that of meaning, and tends to lead to a focus on stimulus/response type reductionism which inevitably leads back to behaviourist thinking.

Affordance of a large flat rock

Consider a large flat rock in an otherwise empty and flat landscape, perhaps in a large natural park. We might explore the affordance provided by the rock to an average human of being climbable, that the possibility for action provided by the rock is climbing. But from an *individual* human's perspective this is meaningless, as there is no attempt to link this with intention. As already explored, intention is a key aspect to affordance, as it defines which of the thousands of affordances that constantly surround us will be attended to at any one moment in time. Humans do not simply climb because they see a large rock, they have intentions and desires. If they want to climb, then the rock affords climbing, and the affordance will be recognised and attended to. If they do not want to climb, the affordance remains, but it is not attended to.

An alternative functional way of exploring this scenario is to say that the rock affords a change in perspective for the human. It still affords climbing in a purely action driven and behavioural sense, and this action is necessary in order to take advantage of the new perspective, but critically from the individual's point of view there is now a need that the rock can meet. As such, the affordance is deeper and more meaningful in itself, as the rock now affords a change in perspective to an individual seeking such a thing - it has been contextualised. The same person might pass the rock on a different occasion, and not notice it, because they had no need to change their perspective at that time. The affordance is not there for that individual, as they have no desire or need to take advantage of what the rock provides or furnishes. For a rock climber, they derive a certain pleasure from the activity of climbing itself, so the rock provides a slightly different affordance, one of pleasure, of achievement, of satisfaction, again deeper than simple physical actions or action possibilities. They do not simply see the rock as climbable, they see what they get back from interacting with the rock, what the rock *provides* or *furnishes*.

An action possibilities approach locks us into thinking about physical achievements. A functional approach allows us to think beyond the merely physical, and identify the individual meaning that the rock might have.

It is perhaps worth noting here that this is not necessarily a uni-directional ontology, a causal ontology where the individual is always acting on the world to meet subjective needs. This is a relational ontology where experiences in the world can equally suggest to the individual what they might do next, if for that individual an affordance exists. If I were to come across a large flat rock in my travels, I would not feel the urge to climb it as I am not a rock climber, but for someone who enjoys that sport the rock would not only have an affordance of climbing, and the relevant deeper affordance of pleasure, but it might also spark in that individual the desire to climb in itself. Norman (1988) alludes to this bi-directional nature of affordance in his interpretation:

> "...the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. [...] Affordances provide strong clues to the operations of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing."
>
> Norman (1988, p. 9)

McGrenere and Ho (2000) interpret Norman's conception of affordance as providing not only as clues as to how things might be used, but also as suggestions to the observer. Gibson was clear that from his perspective affordances were not causal in themselves:

> "Affordances do not *cause* behaviour but constrain or control it."
>
> Gibson (1982, p. 411) [his emphasis]

Nevertheless the ability of experiences in the world to act as suggestions for potential behaviour seems clear, albeit provided that for the individual concerned the affordance already exists.

Affordance of a tree

Hammond (2010) explains affordances using an example of a tree, and what this might offer for an individual:

> "For example, a tree might afford sheltering from the rain; hiding from a pursuer; or even eating and sustenance if the tree is a source of food."
>
> Hammond (2010, p. 205-6)

Using the term 'action possibilities' in this context, it could be argued that the actions present in this scenario are sheltering, hiding and eating. Taking the concept of sheltering in particular, a potentially revealing question can be posed - is sheltering actually an action - or is it a state?

Moving from a state of being rained on to a state of not-being rained on, i.e. moving under the tree, is certainly an action. But *being* under the tree is not an action in itself, it is a state. It is a consequence of an action. From a functional perspective, the tree provides, or furnishes, shelter to an average human. It provides a change of one state - that of getting wet - to another state, that of staying dry. That is the affordance of the tree in this condition. What the tree provides or offers is not being rained on, it offers a change in state, not simply an opportunity for action. It offers something that happens across time, rather than at a specific moment in time.

Affordance of a handrail

Consider the handrail on a set of stairs. From an action possibilities perspective the handrail might afford grasping. It is something that fits an average human hand, and can be physically held on to. The action possibility - and if affordance is synonymous with action possibilities therefore the affordance - is grasping. However grasping has little meaning in this context, many things can be grasped, but that does not explain the relevance to an individual, it does not connect with need or intention.

From a functional perspective the handrail might be better interpreted as affording support. Stairs present a potential risk of falling, and handrails are there to help prevent this by offering or providing extra support, that is the meaning that is understood by the individual, that is the affordance. Grasping may be present as an affordance on a very simplistic level, but the relevant affordance - the meaning that is understood - is support. As we approach a potentially risky situation, we naturally look for ways to mitigate against that risk, but we do not look for things that we can grasp, we look for things that will help support us. We see emergent 'higher level' properties, as Gibson explains:

> "I prefer to call the meanings of things their affordances, that is, what they afford the observer. And the meanings or values of things in this sense are perceptible properties of things, like their shape, layout, composition, and color, although properties of very much higher order."
>
> Gibson (1969) ['purple peril']

Affordance of a lightswitch

A lightswitch would seem to have a very simple affordance, that of switching, or possibly turning or clicking. This is how an action possibilities approach might explain it. Whilst it may 'afford' switching from an interaction perspective, i.e. a Norman perspective, arguably what it provides or furnishes the individual with, i.e. the key affordance from a Gibson perspective, is not switching at all, but illumination - of light. When we see a light switch, what we instantly perceive is the capacity to illuminate, to light our surroundings. There may be an underlying affordance of switching something, the fact that the button is finger shaped and that the resistance is such that a typical human can depress the switch without too much difficulty creates this affordance, but from a meaning perspective and an intention perspective this affordance is empty.

By focusing on the switch from an action possibility perspective, we miss the fundamental affordance of value to the animal, that of illuminating its surroundings. Humans do not wander the world looking for something to switch or click, there is no inherent need that we have for clicking things, which light switches have been created to satiate. From a Gibson and functional perspective, the light switch provides a change in state from dark to light, for an individual with a need for light, the affordance of the switch is illumination. The possibility of lighting a room is the main meaning we 'perceive', not the possibility of clicking or switching

Affordance of a lecture

To take a more educational example, consider a lecture theatre. Laurillard would consider that a lecture affords listening, which can be classified as an action based approach, i.e. to actively attend to another's speech.

> "A large lecture affords listening."
>
> Laurillard (2000, p.3)

Whilst this is true on the level of action possibilities, and might be a useful way for an architect or builder to think about the space in order perhaps to design acoustics, it does not recognise key intentional and invariant aspects of a lecture which are important from an educational perspective.

Arguably the invariant aspects of a lecture that are interesting from an educational standpoint are that (a) the lecturer has an extensive knowledge of a specialist topic, and (b) that they have the capacity to communicate this knowledge in a one-to-many style. It is the invariant nature of a lecture to have these properties, it is how we understand the term lecture is different from, say, a speech or seminar. Bring this together with intention, in that those attending the lecture have the desire or need to broaden their understanding of the topic in question, then a new functional affordance emerges, similar to the rock example above perhaps, of a change in perspective. The lecture can be said not simply to have the very general affordance of listening, but also the specific affordance of providing an alternative perspective.

Affordance of a hyperlink

Previous examples have focused on practical and real world examples to try to illustrate how an action possibilities approach to affordances, based on the work of Norman, differs from a functional approach, which is more in line with Gibson’s original concept. Moving more into digital technologies, it is perhaps interesting to explore how a hyperlink on the world wide web might be explored in a similar way.

From an action possibilities perspective, hyperlinks might be said to afford clicking. However this is a meaningless action, as argued in the lightswitch example above individuals do not simply click for the sake of clicking. To think about clicking in this way might be useful for an interaction designer, exploring different ways in which touch or mouse based interaction might be designed, but it is not particularly helpful from an educational perspective.

An alternative way of thinking about what hyperlinks “provide or furnish” is movement. They allow the individual to move their viewpoint from one digital place to another within the world wide web. If the computer screen is seen as a window through which we perceive the multitude of different websites and other digital places that we can visit on the world wide web, then what the hyperlink affords is a way of moving through and between these places. They answer a need, an intention, they move an individual's perspective from the current point to a new point when new topics or perhaps thinking can be consumed. What is invariant about the hyperlink in general is this ability to provide or furnish movement.

Other examples

If we move away from an action possibilities approach, and try to return to an understanding of affordances that is more aligned with Gibson's original concept, then a new wealth of potential examples can be explored. As Gibson himself wrote when first exploring these concepts,

> "… it has been extraordinarily fruitful in suggesting to the author hypotheses for experiments and in opening up new ways of experimenting on old problems. The important question is whether it will serve the same function for others."
>
> Gibson (1959, p. 499)

Other examples might be drawn out from other everyday items. An apple does not solely afford the action of biting, more critically from the animals perspective it affords sustenance. A book does not so much afford reading, as it affords new perspectives on a topic. A YouTube video does not afford just the action of watching, it affords a simulation of the specific event previously recorded, with all the multitude of affordances that were previously captured. A return to Gibson's original conception of affordance brings back meaning.

Weakness of 'action possibilities'

Arguably the concept of 'action possibilities' has become successful because of its usefulness in designing physical objects and interfaces. But that is about how something might be used, it has nothing to do with the meaning behind that something. Affordances are about the meaning that is provided by the environment with respect to a specific individual and at a specific moment in time. Reducing them to action possibilities distracts from what is arguably the most valuable thing they offer from an educational perspective, that of meaning, and tends to lead to a focus on stimulus/response type reductionism. An action possibilities approach allows the creation of a list of potential actions, for example, for a species for any one object, but it does not explain *why* an individual might choose one of those actions, and the value that they will receive from that interaction. An action possibilities approach is of little analytical use, because it removes intention, it treats the individual as a “black box” of stimulus and response. As Hartson (2003) puts it, when exploring the use of the term affordance in Human-Computer Interaction:

> “... user actions are goal-oriented and purposeful. A user doesn’t click on the screen just because it’s possible. A user clicks to accomplish a goal, to achieve a purpose.”
>
> Hartson (2003, p. 19)

Equating affordances with action possibilities may be a powerful way of simplifying a complex concept, and therefore making it understandable and useable for a broad audience, but arguably removes much of the power of the affordances concept at the same time. The notion of invariants and intention are all but removed, and the connection with environment, and its objects, becomes very much one way, about what the individual can do in the world, rather than what the environment might do to the individual. This particular aspect of an action possibilities approach becomes critically important when applied to a digital environment, a space well documented for its interactive nature, i.e. the way in which objects within the space act back on the individual (e.g. push email, twitter mentions, discussion replies). Arguably this single point could well explain the current problems using an action possibilities affordances approach within educational technology contexts, as it does not allow this particular richness of the digital space to be adequately integrated into a scenario.

Gibson’s theory of affordance has been criticised for being too simplistic (e.g. Turner, 2005), but this is potentially due to the way in which it is so commonly now misrepresented. Far from affordances being a simple concept, limited only to the action possibilities available in the environment, Gibson was proposing an entirely new way of conceiving cognitive processing based on his affordances model. His intention, made clear in later chapters of the Ecological Approach to Visual Perception, was to provide an alternative to the information processing models that were prevalent. Gibson was beginning to suggest a new way of thinking about how we think ourselves.

> "The ecological theory of direct perception cannot stand by itself. It implies a new theory of cognition in general."
>
> Gibson (1979, p.263)

By moving away from action possibilities it may be possible to bring back to affordance that analytical quality that Oliver (2005) observes is necessary, and hence the concept may still be valuable to education, specifically in understanding how digital technologies might be aligned with pedagogical goals.

Affordance as meaningful consequence

Oliver (2005) concludes that Gibson's understanding of affordance "allows us to talk about technology as part of the environment, but not about minds" (Oliver, 2005, p.412), yet it has been argued that the notion of intention that is key to affordances is entirely about minds. Costall's (1984) understanding of what affordances are seems much closer to Gibson's own thinking, summarising them as "functions that objects serve for our activities", Costall (1984, p.113). Torenvliet (2003) similarly suggests a functional approach is closer to Gibson's original idea when considered in a HCI context:

> "Affordances are about not the forms on a screen but the functions behind them."
>
> Torenvliet (2003, p.17)

This use of the word function as opposed to action is arguably at the heart of the current misinterpretation, and refocuses affordances back on to what they provide for an individual, as Gibson intended, rather than simply what the individual can or cannot do in terms of actions. Function suggests something that the individual gets back from the interaction, whereas action only suggests something going out from the individual, there is no sense of the consequences for the individual of the action, yet it is in the consequences that there is meaning. This proposed difference between a functional and actional interpretation of affordance is illustrated below, in Figure 3.4.

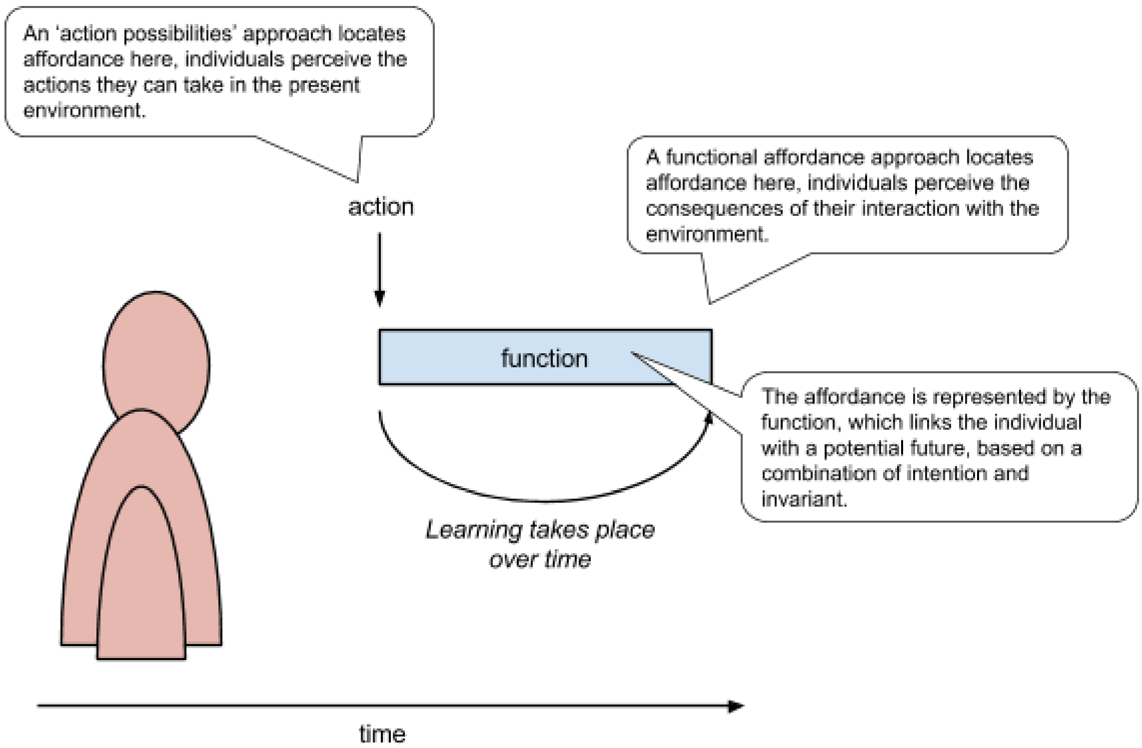


Figure 3.4: Functional versus actional interpretation of affordance

This distinction between action and function, where action is simply about something being made to happen whereas function is about getting something back, is common within the computer programming community, but perhaps less common in other fields. For example, in the C# programming language the two different programming codes ‘Func’ and ‘Action’ differ because Func returns a value - Action does not. Similarly in the Java programming language, ‘Function’ is often differentiated from other programming keywords in that in returns a value once called, i.e. it provides something back. A computer function effectively describes a transaction that takes place, something is sent to the function, and then something else is returned as a consequence of that function.

Even before Gibson coined the term affordance, he recognised that it was in consequences that we understand meaning. He was not so much interested in the *possibilities* of action, as the *consequences* of action:

> “Surfaces are familiar and shapes are useful ... we apprehend their uses and dangers, their satisfying or annoying possibilities, and the consequences of action centering on them.”
>
> Gibson (1950, p. 198)

We recognise and attend to affordances within our environment because they will result in certain consequences for us, they have meaning. As Hammond puts it, “we do not merely respond to the world but know what follows from a response” (Hammond, 2010, p 207). What we perceive and what we understand is the consequences for us, not the action possibilities. Affordances are about consequences, not actions, they are about what will happen:

> “What the philosopher called foresight I call the perception of an affordance.”
>
> Gibson (1979, p. 232)

In effect we perceive the “meaningful consequences” for us of interacting with the environment or objects within it, the potential transaction if you will, and this is what we call affordance. There are parallels here with Vygotsky's understanding of how children view the world, not simply at the present moment, but also in the next moment:

> "Once children learn how to use the planning function of their language effectively, their psychological field changes radically. A view of the future is now an integral part of their approaches to their surroundings."
>
> Vygotsky (1978, p. 28)

We do not see the action possibilities that are present, we have an intention or need, and we see around us spaces, objects, people, etc. that might allow us to fulfil that need. We see something completed. If I wish to carry a large number of books from one part of my house to another, and I see a cardboard box, I do not simply see something I can fill, or something I can pick up, I see a means to an end. A myriad of actions are possible with that box, but I am only interested in what it offers or provides based on my immediate needs, i.e. the ability to move lots of books. I am looking for a consequence, a result - books now in another location - not a series of actions. This direct pickup of information, explained as an affordance, is at the heart of what Gibson was arguing for.

Summary

Chapter 2 explored the history of the relationship between new technology and education, and suggested that the theory of affordances might provide an underlying theory to help understand this relationship. This chapter has explored affordances in more detail, and in particular Gibson's original theory. It has questioned the common understanding of affordances as 'action possibilities' and suggested that affordances are actually comprised of three components: invariants (representing the objectivity of the world), intentions (representing the subjectivity of the individual) and what might be termed the ‘space of possibilities’ of affordances linking these two. This combination of components is referred to within this thesis as ‘the affordances trinity’, and is depicted visually in Figure 3.5, below. This figure will be returned to later.

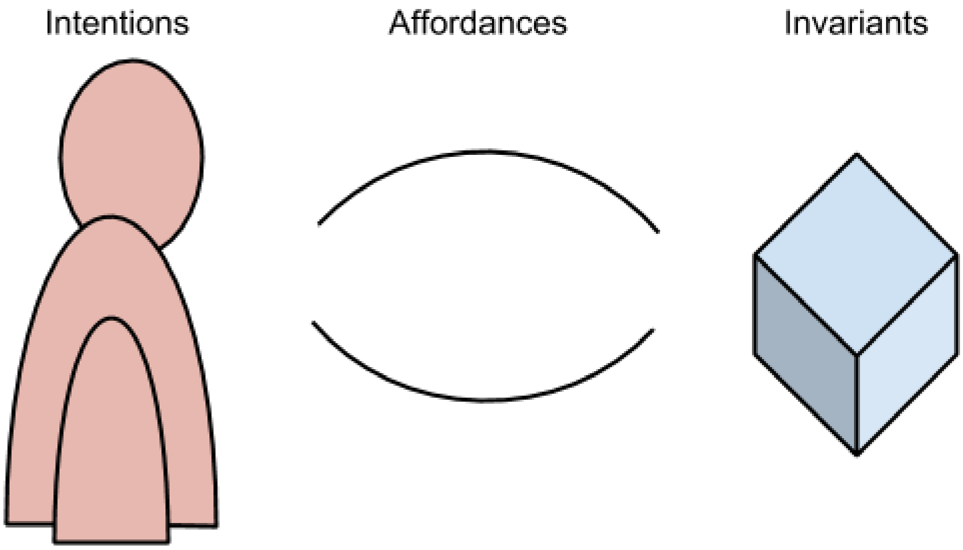


Figure 3.5: The affordances trinity

If the term affordance is to be useful within the educational technology community, there must be clearer understanding as to the meaning of what an affordance is. It has been argued that the most widely held understanding, that affordances are action possibilities, has been derived from the work of Norman, not Gibson, and that this definition is too simplistic for use in educational contexts. By returning to Gibson’s original definition of affordance, in terms of what something might provide or furnish, together with a renewed focus on the two key terms of invariant and intention, this affordances trinity will be explored empirically in the rest of this thesis, and I will show how it has the power to provide a theory of educational technology.

But before moving on to the methodology and methods chosen to explore the affordances trinity, and how it might be relevant in educational contexts, the next chapter will first locate the theory of affordances within the wider ecological model as proposed by Gibson. Affordances so far have been largely explored in Gibson’s original context of the ‘real’ physical world around us. The next chapter will explore the implications of locating the theory of affordances within digital environments.

Chapter 4: The Digital Environment

"A computer terminal is not some clunky old television with a typewriter in front of it. It is an interface where the mind and body can connect with the Universe and move bits of it about."

Douglas Adams, Mostly Harmless (1992)

Introduction

The previous chapter has outlined the theory of affordances in detail, and has suggested that the original concept has become somewhat distorted through re-interpretation in multiple disciplines. It has proposed that a return to Gibson's original conception, with a renewed focus on the importance of intention and invariant, may help to restore the power of the affordances concept and clarify its potential for aligning digital technologies with learning scenarios.

This chapter explores current conceptions of digital space, of the digital environment created by digital computers. This is relevant to the current discussion of educational technologies because the theory being proposed - that of affordance - is part of a wider ecological framework, and an ecology is concerned with the "relationships between a group of living things and their environment" (Merriam-Webster). The environment within which learners are located is therefore central to an affordance perspective, whether it is the real environment or the digital environment that is being experienced. Extracting Gibson's original concept of affordances as a separate component from "The Ecological Approach to Visual Perception" and trying to apply it in a technological context without reference to other key components of the ecological approach, may in part explain why the concept itself is such a divisive one within the educational technology community.

The three components of the environment that Gibson defines in chapter 2 of “The Ecological Approach to Visual Perception”: the medium, substance and surface of the environment, are used to explore how digital affordances may or may not differ in digital places. Comparisons between the real world and the digital world suggest that the current interpretation of affordances as ‘action possibilities’ tends to focus on the surface of digital technologies, on the actions and interactions at that surface. It is argued that the true value of affordances may lay in the place of digital technologies, on their substance and medium, and the potential for transactions with this place that digital technologies might provide.

Arguments for the digital environment

According to Scott (2001), modern theories of learning tend to reject the notion that information simply needs to be transferred from the world into the individual in order to promote learning. Instead they stress the importance of the place of learning, and all that that entails, e.g. the physical, the social, the cultural, etc., what might be called the environment of learning. Whether Dewey writing at the turn of the last century:

> "We never educate directly, but indirectly by means of the environment. Whether we permit chance environments to do the work, or whether we design environments for the purpose makes a great difference."
>
> Dewey (1916, p. 20)

Or Laurillard, writing at the beginning of this century:

> "Education is the design of an environment which will help others learn what experts have articulated."
>
> Laurillard (2012a, p. 14)

The importance of the environment within which education takes place is well recognised. The individual is seen as constructing their own meaning from the environment through experience over time, rather than simply by internalising an external symbolic representation:

> "They view the person and the environment as mutually constructed and mutually constructing. As a result they stress active, transformative and relational dimensions to learning; indeed, they understand learning as contextualised."
>
> Scott (2001, p.37)

However, the environment in this context is implicitly the real world that is experienced, not the digital world. The digital is seen as a subset of this environment, a simulated digital textbook perhaps, or a digital replica of a notepad. I will argue that the digital world is more usefully understood as a digital environment in its own right, and by viewing it in this way what the digital might provide or furnish for teaching and learning, that is to say its affordances, will become more apparent.

The importance of environment for learners is already seen by some as a critical influencing element on learning (e.g. Greeno, 1998), but this is generally concerned only with the physical or real world environment. The digital environment is treated as if it were a part of this real world, when arguably it has certain characteristics or properties which suggest it is not the same, but is simulated in order to *appear* to be the same. Our experience of the real and the digital may be comparable, but this may in part be due to our tendency to replicate or simulate the real world in the digital world

- digital documents that look like A4 paper, digital presentations that look like acetates for overhead projectors, digital photographs that look like passport photographs, etc. Theories that suggest the existence of a separate and distinct digital environment, an environment which might be different to the real environment, have only recently been gaining acceptance (Prensky, 2001a; Prensky, 2001b; Dourish, 2006; Wenger et al, 2009; White and Cornu, 2011).

Digital technologies are often considered as tools or tool systems rather than environments or places to learn (Somekh, 2000; Wegerif, 2002; Shaffer and Clinton, 2006; Oliver, 2013). This in marked contrast to the way digital technologies have been experienced by some learners, with students writing about technology as a “whole new world” (Herrington, 2013a, p. 612) that they never realised existed. Rather than technology as tools to be used, it seems it is experienced more as places to be discovered.

Understanding technology

The word technology is something of a paradox. Derived from the Greek word technologia, itself a combination of the two words technē meaning art or skill suffixed with logia meaning systematic study, it could literally be described as the systematic treatment of an art (Merriam Webster). However the word has grown beyond its origins (Arthur, 2009).

Technology is generally considered as tools or tool systems, as Wegerif puts it “Technology is a broad term for human tool systems” through which “human learning and thinking is mediated” Wegerif (2002, p.2). Wegerif suggests that technology in education is best considered as something to support existing learning practices, but like many others takes a very broad view of technology, including language and the internet in the same definition. Arthur (2009) argues that technology has “at least half-a-dozen meanings”, but that they do not necessarily support each other, indeed they have “overlapping and often contradictory meanings” (Arthur, 2009, p.5). Arthur concludes that technology cannot simply be defined as one thing, instead he coins three separate definitions that can be used in different contexts. Technology is defined as a:

- Means to fulfil a human purpose
- Assemblage of practices and components
- Collection of devices and engineering practices available to a culture

Arthur (2009, p.28)

What is perhaps clear from these definitions from Arthur’s perspective is that technology is not synonymous with tool. Technology may include tools, but it is not equivalent with tools. There is a sense of place, of context, within existing conceptions of technology. Technologies exist as tool-systems or as assemblages, perhaps as collections or as cultural practices, but whatever the specific definition, technology seems broader than a single contextless tool.

Heidegger explores this question is his work "The Question Concerning Technology" (Heidegger, 1977), where he attempts to qualify the essence of technology in relation to human experience of it. In his understanding technology should be considered as an ensemble, a totality, and he uses the German word “Gestell” to describe it. The word has been translated in various ways into English, as an “enframing”, “installation”, “emplacement”, “set-up” or perhaps most usefully considering the current discussion as “the assigning or appointing of a definite place.” (Weber and Cholodenko, 1996, pp. 71, 72, quoted in Friesen, 2011).

Technology as place

Place is a concept which is also central to affordance. Gibson’s specialist terms of medium, substance and surface were coined to help describe the real environment in ecological terms, as places of meaning and experience. They were however coined before the advent of digital technologies, and hence never applied to it. The notion of a separate digital environment, a separate place, is perhaps a challenging one, but arguably the notion of a digital environment is now culturally embedded. Much of the language of digital technology is inherently imbued with a sense of space or place. We talk of web*sites*, *address* bars, *going* online, *visiting* a digital location. Much of the language of the digital is about technology as place, it uses the language of an ecology, and this is increasingly being reflected in the research literature.

One of the most influential developments this century from an educational technology perspective has been Marc Prensky's concept of the 'Digital Native' (Prensky, 2001a, 2001b). Prensky suggested that young people who have grown up in a world full of digital technologies, and who have engaged with these digital technologies all their lives, actually think differently because of this lifelong engagement. He suggested that for these digital natives it was likely "students' brains have physically changed" (Prensky, 2001a, p. 1), when compared with those people who have not grown up with technology in this way, coining the term digital immigrant to refer to this other class of individuals. Arguably concepts of being native or immigrants have within them an implicit notion of place; it is necessary to be native *within* somewhere, and similarly to be an immigrant *to* somewhere.

Although Prensky's concept of the digital native and the digital immigrant has catalysed much creative debate, later research has shown little empirical evidence to support the concept (Bennett et al, 2008; Kennedy et al, 2010). It seems that young people who have grown up in a digital world are not fundamentally different to others after all. Indeed Somyürek and Coskun (2013) have shown that in some cases, far from being digital natives with an implicit knowledge and expertise with digital technologies, some young students appear to be very *weak* users of these types of technologies, with a limited repertoire and a limited ability to apply any existing knowledge to new situations, e.g. in educational contexts.

What is perhaps more interesting is just how popular and pervasive the terms ‘digital native’ and ‘digital immigrant’ have proved to be. ‘Digital native’ in particular remains popular and that popularity is perhaps even growing according to data from Google Trends (see figure 4.1).

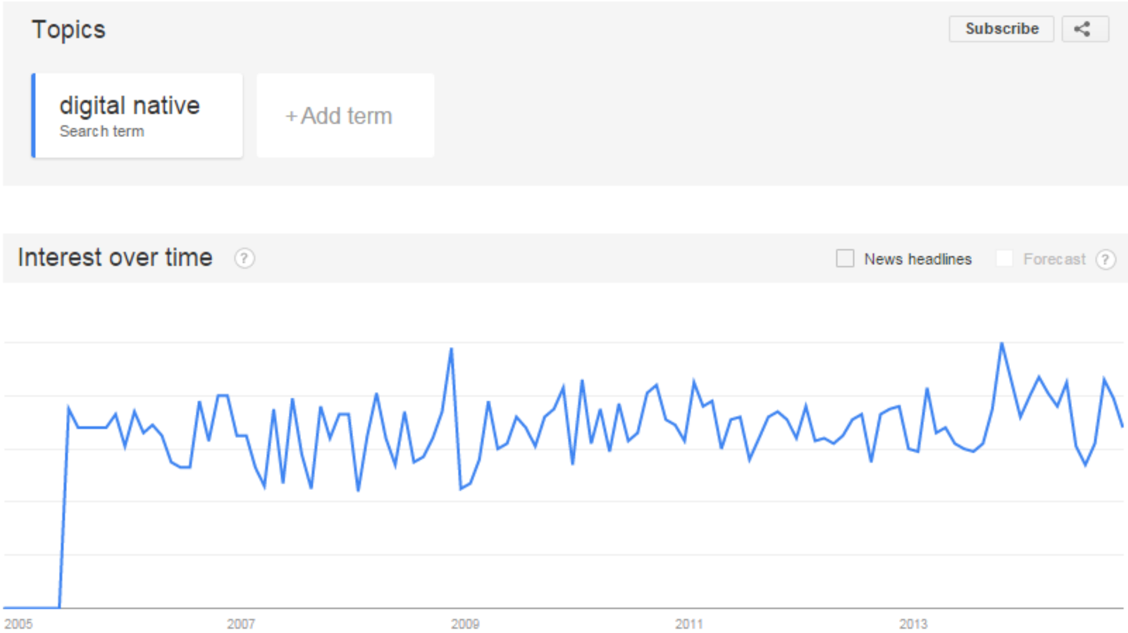


Figure 4.1: Popularity of term digital native according to Google Trends (14/11/2014)

It is proposed that this popularity is in part due to the way in which these terms imply a digital environment. The terms digital native and digital immigrant are entirely about environments, and contrast a new and emerging digital environment of “Computer games, email, the Internet, cell phones and instant messaging” which is now “ubiquitous” (Prensky, 2001a) when compared with the older ‘real’ world where the immigrants come *from*.

Prensky has since moved on from his own native/immigrant distinction, coining the term “Homo sapiens digital” (Prensky, 2009) to describe a new type of human who uses digital tools to extend and augment their abilities. He has moved away from distinctions that use arguments of space, but new models have emerged from other researchers that look to ecological models for guidance. The notion of habitats, for example, has provoked some debate.

Newman and Holtham, writing about the idea of learning habitats, discuss the issue that “e-learning tools are useless without a pedagogic context” and go on to “suggest that a collection of e-learning tools be linked together into an emergent learning habitat” (Newman and Holtham, 2008, p.90). They suggest that we should explore new habitats for e-learning tools, although considering this issue from an affordance perspective perhaps what we should really be considering is not habitats, but niches, as Gibson summarises:

> “Ecologists have the concept of a niche. A species of animal is said to utilize a certain niche in the environment. This is not quite the same as the habitat of the species; a niche refers more to how an animal lives than to where it lives. I suggest that a niche is a set of affordances.”
>
> Gibson (1979, p.128)

This conception of a digital habitat seems to be an emerging thread within some areas of higher education thinking about the role of technologies, and has even been taken as far as the concept of a digital ecology. Diana Laurillard, for example, from the Institute of Education recently commented in an online forum:

> “At IOE we've started referring to 'the ecology of digital tools and resources to support teaching and learning', mainly because this captures the sense of a system that is complex, evolving, diverse, and whose interactions among its human and digital participants regenerate and maintain the community. It's a misnomer, because it's being used to describe the melange of people and digital components, rather than the study of them, so I don't recommend the

> expression, but borrowing from other discipline areas in some way can help to throw light on what we're actually talking about."
>
> Laurillard (2012c)

Wenger et al (2009) have also championed the concept of digital habitats, defining a digital habitat as "an experience of place enabled by technology" (Wenger et al, 2009, p. 38). They propose that the way in which digital habitats - or potentially environments - are experienced can be summarised through four perspectives:

1. The tools that support specific community activities;
2. The platforms into which vendors and developers package tools;
3. The features that help make tools and platforms usable and 'liveable'; and
4. The full configuration of technologies that sustains the habitat (which is rarely confined to one platform).

(Wenger et al, 2009, p. 38)

Another emerging concept of digital environment is centred on the notion of visitors and residents. White and Cornu (2011) coined the terms digital visitors and digital residents, attempting to build on Prensky's model of natives and immigrants, but unlike Prensky without making a specific distinction about age. Their digital residents and digital visitors model again implies a sense of digital place, but in their case the digital place is specific and localised, the concept of simply growing up with digital technologies and therefore somehow being competent with all digital technologies is replaced by a more nuanced version, where individuals are resident in some digital places, but perhaps only visitors to another. However their place is a hybrid that includes the real and the digital, as they explain:

> "… our definition of place does not make a hard distinction between the virtual and the physical; on the contrary, we are proposing that place is primarily *a*

sense of being present with others."

White and Cornu (2011, section III) [their emphasis]

Their visitor/resident distinction is also a continuum between the two positions, rather than exclusive positions, where individuals can be placed somewhere between these points rather than exclusively at one end or the other. Their specific point on that continuum is determined by their motivation - or perhaps more appropriately in the present context, and in the language of Gibson and of affordance, their specific point on that continuum is determined by their *intention*.

Distinguishing space and place

Up to this point no particular distinction has been made between the terms space and place. These two words have used more or less interchangeably, though it has been argued by some that they should have more precise meaning. This section explores these meanings and attempts to give the terms space and place more specific definitions within the present discussion of digital environments.

Harrison and Dourish (1996), taking their inspiration from architecture, argue that space is not synonymous with place. In their own words, "space is the opportunity; place is the understood reality" (Harrison and Dourish, 1996, p.1). For them space is the potentiality within which places can emerge. Space is a 'pure' concept, it is used to describe a place which has yet to be filled by people, as it is the influences of people which transform spaces into places. Place is not only somewhere that can be located, it also has cultural and social dimensions which are a product of their original designers intentions and the people who use and occupy them.

Ryberg and Ponti (2004) use architectural metaphors in their work on networked learning environments, and make the distinction of virtual places within virtual space. They argue that a focus on digital technologies as tools has failed to identify the importance of the wider *place* of learning in “network-based learning environments”, critically neglecting the social context - a key component of a socially constructive theory of learning.

Wahlstedt et al (2008) also look to the design of physical places for their inspiration, and agree that “spaces are converted to places by people” (Wahlstedt et al, 2008, p.1022). They argue that there is something of a predisposition for designers of digital environments to focus on the space rather than the place, i.e. the technical design rather than the social design, which the possibly unintended but potentially profoundly negative effect of restricting the ability for those within a space to make it their own, to turn space into place.

Ciolfi (2011), exploring how individuals experience the boundaries between digital and real environments, notes that “place is made by people appropriating and living within a physical environment” (Ciolfi, 2011, p.106), and clarifies that although digital environments have a sense of place in themselves, the experience of this place runs in parallel with the experience of the real place within which the individual is physically located.

From the perspective of Harrison and Dourish (1996), place is inside space, but space is simply the opportunity for place, whereas place is:

> “... generally a space with something added - social meaning, convention, cultural understandings about role, function and nature and so on.”
>
> Harrison and Dourish (1996, p.3).

From this perspective digital technologies could potentially always be considered as places, inasmuch as they always contain at least some value of social meaning, convention or cultural understanding. This initial meaning is provided by the designer(s) of the place itself, their choice of code, their style of coding, their experience and outlook, all of this influences how their code is written. This in turn directly influences individuals using the places coded by the designer, it changes how an individual experiences the place realised by that code. Unlike real spaces and places, digital places are all manufactured or created, there is no digital equivalent of a tropical rainforest or temperate desert, i.e. pure spaces than can become places, digital places always contain human presence by their very nature. In this understanding digital space becomes only a theoretical construct that it is necessary to support the notion of digital places. Arguably a ‘pure’ digital space cannot exist, it has no existence by itself. Digital space is the potential, digital place the realised actual.

This thesis adopts these distinctions between space and place. It uses the term digital space to refer to the potentiality of the space created by digital technologies, and digital place to refer to the realised places created within this potential digital space.

The nature of digital space

These concepts of digital spaces and places, of digital environments, are not entirely new. Indeed, similar ideas are sporadically referred to in the literature on affordance. Albrechtsen, for example, writing about the implications of the concept of affordance in the HCI community writes:

> “An information system is an artificial environment, constructed by designers, constituting a hypothesised or potential ecology within which human environment mutuality can be performed.”

Albrechtsen et al (2001, p.9)

What is perhaps particularly interesting about Albrechtsen’s perspective is the notion of an artificial environment. He recognises that this new digital environment has been constructed, unlike Gibson's conception of the real world which man can only tweak to suit his own needs, the digital world is artificial - it is a created world, a simulated world. The novelist Douglas Adams quote, which begins this chapter, neatly summarises the potential power of digital computers as "an interface where the mind and body can connect with the Universe and move bits of it about", but what is perhaps missing from that statement is that it is a *simulated* version of the Universe, not the Universe itself.

In a real world learning scenario, affordances are relatively easy to understand. Chairs might afford sitting, for example, and crucially from a learning perspective they might also afford rearrangement into patterns which better support group learning or other collaborative learning approaches. The very fact that they are detached objects, to use Gibson's language, provides an affordance which can be taken advantage of pedagogically. It is perhaps interesting to note here that they do not necessarily have a pedagogical affordance, they have *affordances which might be taken advantage of from a pedagogic perspective*. An average sized human has the capability to move the chairs and reorient them, perhaps to support a change from a didactic to a dialogic mode of learning. It would, though, be stretching our language somewhat to suggest that chairs afford dialogic learning simply because they can be moved around.

This is, perhaps, a subtle distinction and arguably irrelevant, though it has earlier been suggested in Chapter 3 that attempts to categorise affordances (e.g. Hartson, 2003; Zhang, 2006) are unhelpful and limit the usefulness of the theory. The difference between a pedagogical affordance and an affordance which has pedagogic application may be subtle, but underlying that subtly lies an attempt at categorisation of the world which is in tension with one of the core concepts of affordance, that of relativity. Affordances are relational, they depend as much on the individual concerned as the object or place concerned. To map affordances specifically to one category runs the risk of denying this relational character.

The real world has a long legacy of design and redesign, so that the objects we are generally surrounded by have a wide range of affordances that have been shaped and reshaped by many minds over the centuries, filling up the many habitats or niches that Gibson observed existed within the environment (Arthur, 2009). Not only is there this breadth of design and redesign, but there is also a huge depth of creation within any one specific type of object in the environment. Modern day pens, for example, come in a huge range of different designs, shapes, sizes, etc. We can imagine a scenario many decades ago when there were very few types of writing implement to choose from, but today pens and other writing implements offer a huge range of affordances which can meet the needs of an equally huge range of individuals. Fat or thin, cheap or expensive, durable or disposable, child or adult, this list goes on.

The situation with affordances in the digital environment is rather more complex. As Albrechtsen et al (2001) notes, the digital environment is an artificial environment - or what might be more specifically identified as a simulated environment. As such it is at the beginning something akin to a blank canvas. In one sense it affords nothing, but at the same time it *may* afford everything. It is a space of potential. There is no long legacy of digital to base new work on, few conventions that are now accepted, little “combinatorial evolution” (Arthur, 2009, p.18) producing coherency within digital environments. However, the consequence of this empty beginning is that we are constantly looking for metaphors from the real world that we can transfer into the digital space and hence allow visitors to this space to understand it, to perceive it, and to move within it.

Some theorists have suggested that it is this simulated nature of digital space that is the key to unlocking its educational potential. As Dawes and Wegerif summarise:

> “Representations of every kind are also a mindtool that allow us to objectify our thoughts so that we can reflect upon them ... Computers can helps learners

> capitalise on this by allowing the direct manipulation of representations”.
>
> Dawes and Wegerif (2004, p. 52)

Seymour Papert’s work on constructionism is perhaps the most well-known of these attempts to link simulation with learning. He felt that the power of the computer to simulate was its key value to education:

> “The computer is the Proteus of machines. Its essence is its universality, its power to simulate.”
>
> Papert (2003, p. viii)”

By using computers to help students construct and visualise abstract ideas he hoped to improve the thinking of students. His work has been seen to have mildly beneficial cognitive effects (Liao and Bright, 1991; quoted in Kirkwood, 1998), but has arguably been much more valuable in highlighting how digital technologies can be used to provide a simulated space for learning. These new digital spaces ability to "support educational opportunities that are not constrained by temporal and spatial considerations" (Schneider, 2008, p.1) marks them out as having the potential to offer affordances not readily available in the real world. They have “the potential to make possible what had previously been impossible.” (Hoadley, 2002, p.3). But this perhaps raises an interesting question, what are these digital spaces made from, from a theoretical perspective? Returning to Gibson’s ecological approach may provide the beginnings of an answer.

Medium, substance and surface

A key aspect to affordance is that the theory was not written solely about objects. Gibson (1979) talks about affordance in terms of medium, of substance, of surface, of objects, of people/animals and of places. He talks about affordances in terms of *environment*. He was writing, however, in a pre-digital world, a world where computers were a rarity and the notion of having a personal computer had only just become a commercial possibility. Computers were, in general, very large and powerful mathematical machines used to solve complex scientific and engineering problems and had limited visualisation capabilities (Kennedy, 1999). There was no sense in which they could be considered as environments in their own right.

Affordances were firmly located in the real world, but Gibson recognised that the way in which this real world was scientifically described made it difficult to apply a theory of affordances. The prevalent scientific model, using theory from physics, chemistry, biology etc. was useful for predicting and describing, but not for *experiencing* (Gibson, 1979). From Gibson's perspective, the environment was a meaningful place, an experiential place where changing context was more important than snapshot measurement. In order to understand this environment from an ecological perspective, Gibson created an ecological framework within which affordances could be located. He described three main categorisations that together make up the environment: Medium, Substance and Surface (Gibson, 1979).

The term Medium is used to describe what something is suspended and/or supported within, e.g. the air, water or earth that animals move within. Mediums can be insubstantial (e.g. air) or substantial (e.g. earth) or somewhere in between (e.g. water). They tend to be "relatively constant and relatively homogenous" (Gibson, 1979, p. 18). They have different affordances for animals in a relational manner as all affordances do. For example, birds can use the air to move within, but not the water. Fish can use the water to move within, but not the earth. Worms can use the earth to move within, but not the air, and so forth. Medium is a central concept to affordance as it is the space within which all other potential experiences occur.

The term Substance is used to describe the things that are encountered within this medium, and crucially what these things are made of. It is "the portion of the environment that does *not* freely transmit light or odor and that does *not* permit the motions of bodies and the locomotion of animals."(Gibson, 1979, p. 19 [his emphasis]). Examples might be clay, wood, metal, etc. Substances have their own affordances, e.g. clay may be malleable, wood might be burnable, metal may be reflective, etc.

The term Surfaces is used to describe the boundary that exists between medium and substance, the layer of separation. This is what animals actually perceive within the environment, the changing nature of the surfaces within the world as we move within it, and the manner in which light and other objects interact with surfaces. Surfaces are important because they are "where most of the action is" (Gibson, 1979, p. 23).

These three terms provide a triad that Gibson used to describe the environment of the world from an ecological perspective. Understanding them is central to understanding affordance, as the invariance that lies at the heart of affordance is located in the medium, substance and surface of the environment. But although these terms were coined to describe the real world, it is perhaps possible to apply them to the digital world and by doing so expose how conceptions of affordances have become focused on one aspect of this triad, that of surface. The description of digital habitats as proposed by Wenger et al (2009) earlier in this chapter gives one frame within which to explore this application. Wenger et al described a digital habitat as containing tools that support activity, platforms that package these into one, features that make these tools and platforms useable, and the 'full configuration' that brings this together.

- The platform within which these tools are experienced can be seen as synonymous with *medium*, perhaps the Operating System that individuals move within and experience the digital environment, whether Microsoft Windows, Apple OS X, or perhaps some form of Linux.
- The tools that are built need to be made from some form of *substance*, in the digital world this would probably consist of the programming languages that are

commonly used to create digital objects, such as HTML, VB Script, Java, etc.

- The features that make this environment useable might be considered as the interface *surface*, with its specialist disciplines of interface design and human computer interaction (HCI).

What emerges from this comparison is a potential split between the place that is experienced, in terms of medium and substance, and the interface that connects us to that place, in terms of surface. Arguably action possibilities lie in the interface, in the surface, as that is where it is possible to interact with the place, to take action. This would potentially explain the popularity of the term affordance within the HCI community. If however, affordances are more than action possibilities, the question remains what affordances might be possible with the digital place as opposed to the digital interface.

In order to explore this application further, a thought experiment is proposed: *what affordances do digital technologies provide without electricity?*

Imagine the desktop computer when turned off, sitting idly in the library, perhaps surrounded by empty coffee mugs and well-thumbed books. Or a laptop or tablet computer, lying on the study desk, screen dark, cold and lifeless. To talk about these technologies in terms of digital place seems nonsense, no one would question whether or not these items are part of this world or another, whether they exist in the ecological world that Gibson was describing or not. They are obviously part of this world and nothing else, and consequently they have various classic affordances, from an action possibilities approach to affordances at least. The desktop computer will almost certainly have a mouse that by its very dimensions and shape fits neatly into the average hand, and therefore affords grasping. In this position it will also have one or more buttons that are designed to lie under the fingers, and these naturally afford clicking with the fingers. It will be light enough that it will easily afford sliding over the desk itself. The screen will be positioned at an angle and height, and will have the necessary dimensions that it appears very much like a window, and therefore affords looking into (or through). The laptop or tablet will be designed to be sufficiently light and small that it can be picked up and manipulated by the hands without a great deal of effort, with surfaces that allow it to be grasped securely. It too will have a display screen of some form with similar proportions to that of the desktop, although almost certainly significantly smaller. In this scenario though the technology is off, it has no power, so the affordances are relatively obvious. The medium that they are suspended in is the normal air we are used to, the substances are the traditional metal, plastic and glass that again is commonplace to us, the surfaces presented by these substances are well known to us, with the glass reflecting ourselves much as mirrors might do.

Now imagine turning these devices on.

As they hum and spin into life, various images come and go on their screens, various sounds emanate from their speakers, and eventually the glass windows that once were dark now show new places. They no longer show reflections from the real world, they now show the simulated world of the digital environment. The simple actions that were possible before, the affordances of the physical, have now been added to by a wealth of new actions, the interactions of the digital. The medium, substance and surface that were perceived have been extended and augmented by the medium of the operating system, the substances of digital objects and the surfaces of the user interface. There is a curious difference, however, in how the surfaces and substances of this new digital environment relate to each other, which is perhaps worth exploring further.

Imagine a painting in the real world, perhaps one by the old masters, demonstrating the emergence of a new form or school of painting. The image is bound by the physical rules of this reality, the surface (in Gibson terms) is locked together with the substance (in Gibson terms again), and as the substance (in this case paper) is fixed so the image itself is fixed. It can be tilted and moved with a 3 dimensional space but its physical size will always remain constant.

Now consider the digital equivalent, what happens when the object is digitised to that it can be simulated and then explored in a digital place. The surface and substance in this case are not bound by any physical law, some of the invariant behaviour of paint and canvas has been lost in this simulation, and hence the image can be made much bigger or smaller as a consequence. It is a central affordance of digital space, and a direct consequence of being a simulated environment and therefore one that is not subject to the same physical laws that govern real space, that digital objects within it can be resized. In fact to be completely accurate there are two distinct affordances that can be applied to digital objects. Objects themselves can be resized, i.e. they can be made larger or smaller, but at the same time the perspective of the viewer can be altered, i.e. it is possible to both zoom in and zoom out - to change the perspective of the viewer in relation to the object. Surface and substance are now separate, they provide separate affordances. In an educational context, this allows learners to explore in great detail how the textures of the paint were layered and composed.

It might be argued that this is equally possible with a microscope or a magnifying glass, but that is not entirely true. A microscope or magnifying glass bends the light, effectively bringing the eye of the user closer to the image, zooming in if you will - but it can never change the size of the object itself. The object - the painting - is bound by the physical laws of the real world within which it exists, its size is invariant. In the simulated space the object itself can be made larger, size is not invariant, with the result that a massively zoomed image can be explored on a massively large screen. Affordance and invariant are implicitly tied together, new invariants mean new affordances.

Note that these are theoretical affordances of the digital space itself, the fact that these affordances are theoretically possible does not mean that they are necessarily available, they are *potential* affordances. Whether or not these affordances are *realised* in a specific digital place is up to the designer of the interface that connects the viewer to the object. They may well deny either or both of these affordances, either by design or simply out of ignorance of their potential use for the viewer.

The digital technology Prezi is perhaps a good example of a digital place that utilises this potential to provide an infinite canvas to create on, and which allows the visitor to both change the perspective onto digital objects, and also to change the sizes of digital objects within that canvas. The digital technology Notepad (within Windows) or similar types of software is perhaps a good example of technology which constrains the space within which to create, and only offers a fixed perspective.

Interface vs place

The situated view of learning suggests that affordances are only part of the learning equation; we also need to consider constraints (Greeno, 1998; Kennewell, 2006). As Greeno defines it,

> “Learning ... is hypothesized to be becoming attuned to constraints and affordances.”
>
> Greeno (1998, p.11)

When considering the digital environment, an implicit constraint that is not perhaps widely appreciated is that any digital space needs to be reached through an interface, and that this interface imposes certain constraints above and beyond what the space itself may constrain. Indeed, it has been argued that digital space in itself might have unlimited potential, it is a ‘space of possibilities’, but the interface we use to connect to that digital space is far from unlimited. The computer screen can be seen as a window or portal, through which we can peer into the digital space on the other side, but much of who we are, what we can do, and what we can sense fails to pass through that window.

Gibson (1966) argued that the senses together provided a perceptual *system*, that they should not be considered individually as meaning is derived from the combined inputs from all senses in real time, not from a recombination of disparate senses by some internal homunculus. As Gibson notes, an individual is normally immersed in experience, they exist in spaces and places with virtually unlimited potential for experience. The environment we live in provides “an inexhaustible reservoir of information” (Gibson, 1966, p.269), and that this information is conveyed through all our senses combined. Dewey agreed that:

> “It is not just the visual apparatus but the whole organism that interacts with the environment in all but routine action.”
>
> Dewey (1934, p.122)

The notion that we have only five senses is now widely discounted. Although exactly how many senses we may or may not have, and how they are measured and identified, is still a point of discussion (Macpherson, 2011), the fact that we have many is beyond reasonable doubt. Potentially our senses may be related to chemoreception (salty, sweet, etc.), photoreception (colour, motion, etc.), mechanoreception (impact, motion, etc.) and thermoreception (heat, cold, etc.) (Boundless, 2013), perhaps even more. Of these only a very limited selection of photoreception and mechanoreception are actually available to us through the average computer interface, with some ability to perceive (usually limited to two dimensions), and the ability to project perhaps one finger or maybe two into the space beyond the screen.

Digital environments are naturally constraining from a senses perspective, as the number and quality of the sense data that can be transferred and received through the interface into the digital environment is hugely constrained by that interface. The differing capacity that different media forms have for transmitting non-verbal and other non-language (e.g. vocal) cues has been well documented, and has been referred to as the ‘social presence’ of that media (Short, Williams and Christie, 1976). Whilst precise definitions of social presence are still being debated, Tu and McIssac define it as "the degree of salience of another person in an interaction and the consequent salience of an interpersonal relationship" (Tu and McIssac, 2002, p. 38). Digital places, whilst theoretically unlimited in *potential,* are only generally experienced through small windows, through an interface which drastically constrains this notion of presence. We are hardly ‘immersed’ in information. This tendency of digital technologies to mediate communication is well documented. However, if digital technologies are conceptualised as providing space and place this mediation can be located in the interface to the digital technologies, rather than the digital space itself. This distinction is subtle but powerful, but it is perhaps difficult to conceptualise. A short thought experiment will perhaps clarify.

Consider the two ellipses, presented on two separate computer screens, in Figure 4.3. Two individuals, perceiving the same digital place, but through two different interfaces (i.e. two different computers). In one image, the two ellipses appear larger and slightly rotated compared to the other image. This is because one of the individuals viewing the ellipses has chosen to change their perspective. This is a property enabled by the local interface. However, the ratio between the two globes remains exactly the same; the digital objects have not changed.

Figure 4.2: Mediating effects of the interface vs the place

The ellipses themselves are located in a digital place remote from both viewers, and their physical size and relative proportions remain constant. The way they are perceived can be shifted as a result of local interfaces, but the objects themselves remain constant in their digital place. There are invariants in the local digital interface, and there are invariants in the digital place, and - crucially - these are *independent of each other*. Classical computer mediated communication tends to view the computers as effecting some form of change to the communication as it passes through them, mediating the message. Computer mediated communication has been defined as "any communication patterns mediated through the computer" (Metz, 1992, p. 3). The present argument proposes that computers do not provide a single mediating effect, mediating effects of the interface and mediating effects of the place are separate and can be independent.

Hui recognises that the digital world creates both the place that is experienced and the way to experience that place. As they phrase it when discussing the world wide web, “[it] is acting both as an interface between users and digital objects and as a world in which these digital objects conceal and reveal” (Hui, 2012, p. 381). Figure 4.4 attempts to further clarify this difference between interface and place. In the left hand side of the figure, the computer is represented as the line between individuals, creating a mediating effect between those individuals. However this analogy gives no room for the digital place of experience, the computer is seen as directly connecting the two individuals. The right side of the figure attempts to show a different conception of this connection, where the computer interface is shown as mediating sense data, but this is separate from the digital place itself. In this version, each individual may perceive a different mediating effect through their own computers, but the place as experienced remains constant.

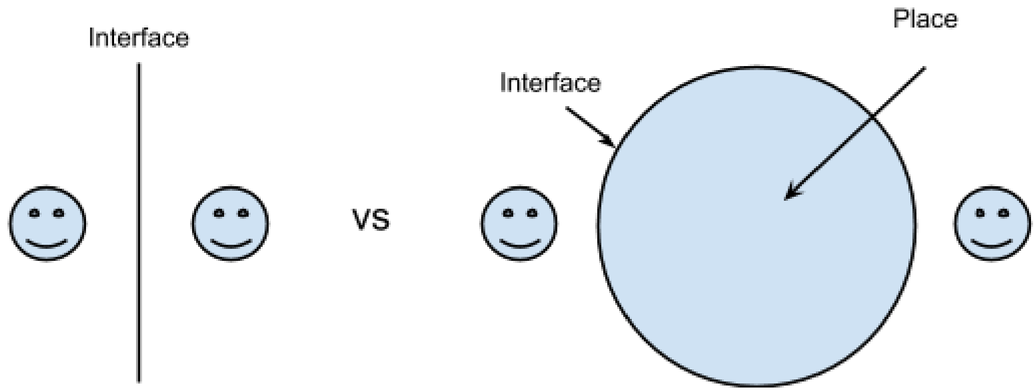


Figure 4.3: Interface and place

Figure 4.4 highlights in particular that individuals experience different interfaces when exploring digital space. The effects of the interface on one individual may be completely different to the effects of the interface of the other individual - they may be using different devices, with different functional properties in order to view the place, and this will in turn significantly alter and impact their experience. One perhaps exploring the place using a powerful desktop computer with large screens, a physical mouse and keyboard, and speakers, another perhaps using a smartphone with a small screen, no keyboard and headphones. The interfaces presented may well be very different, but critically the content experienced will not be. In this model affordances of the interface and affordances of the place can be considered independently of each other.

Together these conceptions of separate mediating interfaces and digital place provide a new visualisation of digital technology, which is depicted in Figure 4.5. This conception recognises the dual nature of the interface and the place, separating the two.

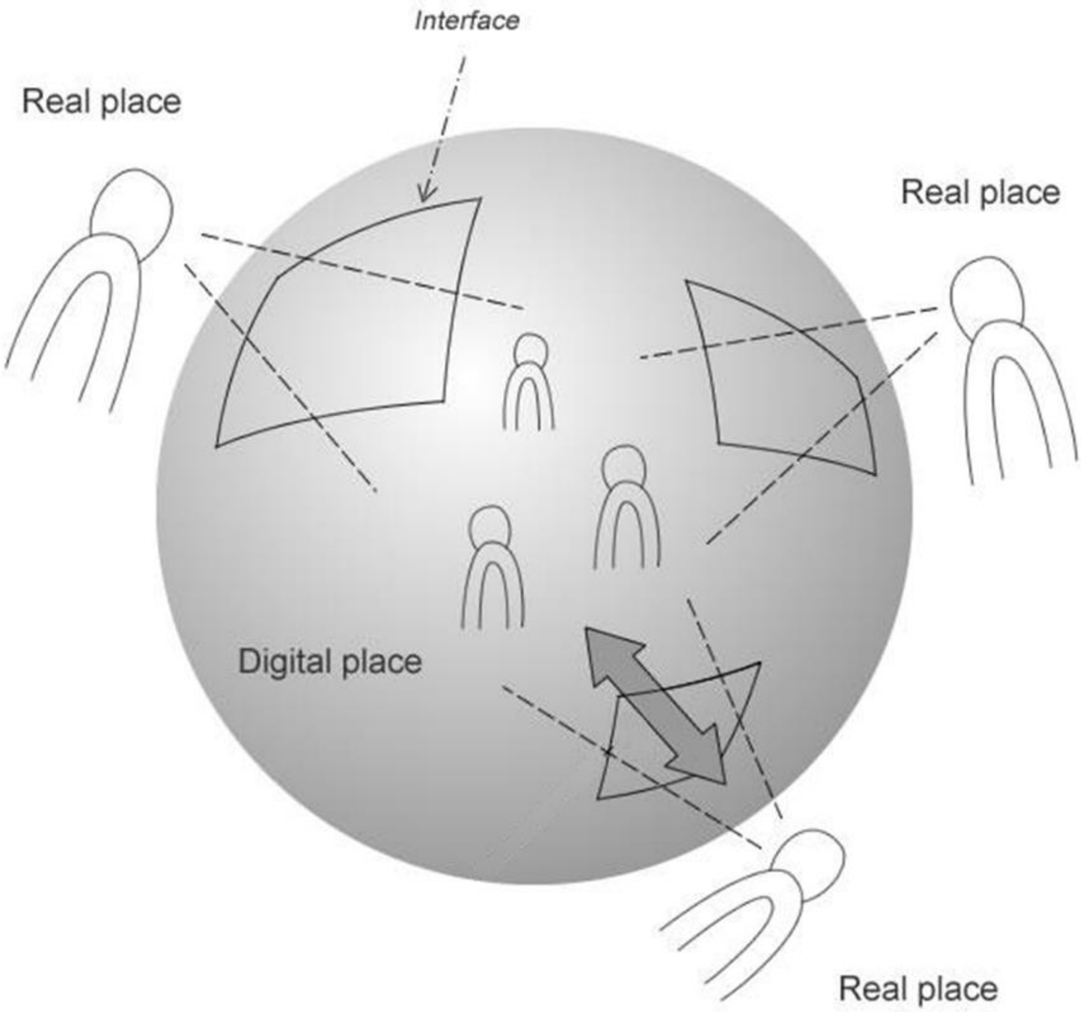


Figure 4.4: Real places and digital places

Figure 4.5 shows how ‘windows’ or ‘portals’ onto a digital place exist for multiple users in multiple ways, and how interface can be considered as different from place. It also depicts the simulated avatars of individuals within the sphere of a digital place, which may or may not replicate those individuals as they appear in the real place. It also indicates using a broad bi-directional arrow the transaction between the real place and the digital place, and hence the simulations within that digital place.

Summary

Gibson's original conception of affordances considered that the environment was just as likely to affect the individual as the individual was to affect the environment, in what might be termed a transactional understanding. It was an ecological approach that saw the environment as actor on the individual, just as much as the individual was actor on the environment. Gibson explicitly recognised and addressed the issue of place and affordance:

> "The different places of a habitat may have different affordances. Some are places where food is usually found and others where it is not. There are places of danger, such as the brink of a cliff and the regions where predators lurk."
>
> Gibson (1979, p. 136)

But this place was always the real environment; Gibson was writing in a pre-digital world. This chapter has explored how the theory of affordance might apply to the digital world; to the medium, substance and surfaces which comprises the digital environment. It has attempted to make a distinction between the mediating effect of digital interfaces, and the meaningful place of digital experience, to open up the debate around the potential of the affordances concept. It suggests that a wide range of affordances will remain hidden if digital technologies are considered simply as tools; they may act as tools, but they are also places in their own right, with invariant properties and consequent affordances that arise directly from this sense of place. The affordance, not the technology, becomes the tool. The technology becomes the place.

Learning is also recognised as something that happens in a place, it is situated (Brown, Collins and Duguid, 1989). The learning that might take place in any one place is partly dependent upon that same place, and these places are increasingly not only real places but also digital places. A perspective which fails to grasp the sense of place that is provided by digital technologies, consequently fails to take advantage of how that place might support the broader learning process.

Hammond suggests that the theory of affordances could provide a useful way of discussing the value of digital technologies for learning, because it “points us to the right question: how do user and tool come together?" (Hammond, 2010, p. 215). The concept of digital technologies as spaces and places outlined in this chapter provides a potential update to that question, one that will be explored empirically in the following chapters, “how do user and place come together?". By using the affordances trinity as a “tool to structure inquiry” (Dewey, 1916, from Antonenko, 2014, p. 5), within a situated view of learning, the experience of learners using digital places for learning will be observed, analysed and evaluated in order to better understand whether affordance can be used as a design tool to align pedagogy and technology.

Chapter 5: Research Methodology and Design Overview

> *"If you want truly to understand something, try to change it."*
>
> Kurt Lewin

Introduction

The overall goal of this thesis is to understand whether the theory of affordances can be used to align digital technologies with pedagogic goals. Methodological approaches suitable to explore this goal are briefly compared, and post-positivism is suggested as the most suitable perspective within which to frame the research. A specific methodology that works well under this paradigm is design-based research; it's applicability to the current research is discussed and an overall research design using design-based research is outlined. Brief descriptions of specific design methods are mentioned, with more detailed design narratives and analysis continued in Chapter 6 and Chapter 7.

Methodological approach

Chapter 3 has challenged popular conceptions of affordances, and has argued for a return to a more fundamental understanding of the theory based on Gibson's original ideas, but recast for the digital age. Affordances are no longer reduced to 'action possibilities' at any one moment in time, but are tied to an individual's intentions in an extended and continuous experience of their environment. The notion of invariants is also given more prominence, in that it is the invariants that are detectable in the environment that allow affordances to exist, and as such they must play an integral role in an overall theory of affordances in the context of educational technologies.

Chapter 4 has suggested that digital technologies should be considered as providing a digital environment, rather than simply as digital tools, a way of understanding digital technologies that allows for their exploration over an extended period of time rather than as one off interactions. It has proposed that digital technologies provide 'digital space', space which is experienced and occupied by people in the form of specific digital places.

The first question this chapter addresses is the type of methodological approach that is appropriate when undertaking research into the intention and invariant which is at the heart of the affordances concept, specifically when considering digital environments. Outlining a suitable methodological approach sets the research paradigm under which the research is being undertaken, a way of thinking about the world which blends research needs with an epistemological outlook.

Classically methodological approaches are typically split between two camps, positivism and interpretivism, with the former generally associated with 'scientific', i.e. science, research and the latter with social research. These two overall paradigms can be loosely connected to the two predominant research approaches for data gathering, quantitative approaches and qualitative approaches (Patton, 2002).

Positivism

Positivism, the belief that reality is stable and that it can be viewed and researched from an objective viewpoint (Levin, 1988; Beck, 1979) is generally viewed as the more trustworthy of the two, as Hirschheim (1985) puts it:

> "Positivism has a long and rich historical tradition. It is so embedded in our society that knowledge claims not grounded in positivist thought are simply dismissed as unscientific and therefore invalid."
>
> Hirschheim (1985, p.33)

However as Hirschheim goes on to discuss, when applied to Information Systems such as those generally experienced when discussing digital technologies, the positivist approach presents problems. Whilst at first a positivist approach would seem ideal, given the predictable and mathematical basis for computation and hence all digital technologies, this leaves out the human dimension from the research, potentially leading to variability and unpredictability in results. Humans can be considered as doubly involved in digital technologies, as embedded cognition within the systems itself, and as the users of the system in terms of human-computer interaction. Following a positivist approach would run the very real risk of only measuring that which can be discretely measured, and leaving unresearched critical human elements of the process (Galliers, 1992).

However, positivism would see the ideal approach in trying to understand the *invariant* aspect of the affordances concept, as these invariants are defined as aspects of the world which are permanent and objective. The way an object such as a ball falls through space, for example, would appear to be invariant, as it can be described by various physical forces in a positivist manner, irrespective of the role of any observer.

Interpretivism

Interpretivism is the counter to positivism, a way of viewing the world which eschews the defined materialist view, and considers the researcher part of the overall research 'system'. Interpretivism contends that objective reality is 'neutral' (Cohen et al, 2000), that true understanding and meaning is both subjective and personal. Research is generally carried out in real world scenarios, and there is an implicit understanding that the researcher will have an impact on the events under examination. Knowledge about what is actually happening within the situation under study is ‘interpreted’ by the researcher using tried and tested rigorous processes. Interpretivist approaches would seem ideal, therefore, for studying the overall concept of affordances, in that affordances are not permanent aspects of objects within the wider environment, but personal conceptions of the value or meaning of the world and objects within it relative to a specific individual and their intentions.

For the ball falling through space example above, the invariant information remains the same but it would have different meaning, i.e. affordance, for different individuals: An individual inclined to sport may feel the need to catch the ball, a nervous child may fear the balls impact and hence avoid it, a photographer might experience the desire to capture the moving ball on film, etc. The same scenario can be viewed either positivistically or interpretively

Researching affordances therefore presents something of a methodological challenge, in that the concept of affordance spans the dichotomy between objective and subjective (Gibson, 1979); in terms of the current methodological discussion, spanning the dichotomy between positivism and interpretivism. The overall concept of affordance might lend itself to an interpretivist approach, yet the underlying invariants that give rise to the affordance are more suited to a positivist approach. This tension leads us to a third possibility - a post-positivist approach.

Post-positivism

Post-positivism arose through perceived weaknesses in the positivist approach, and suggests that the world is not based on “unchallengeable, rock-solid foundations”, Phillips (2000, p. 26), but instead is based on conjecture, and that evidence to support claims needs to be made, or warranted, but always with the proviso that such warrants may be incorrect, and are subject to revision should further research challenge them.

In the ball example above, a post-positivist interpretation might agree that the ball appears to be moving in an invariant way, but if we attempted to describe in detail exactly how the ball moves we would rapidly run into problems of disagreement between different observers. The specific language that should be used would undoubtedly be difficult to agree upon. However within a specific community of practice who are familiar with a shared vocabulary (Wenger, 1999), a level of agreement should be possible. Whilst we might never be able to decide on a level of absolute truth about the ball, we should be able to agree key aspects to its motion, and what this might mean to individuals. We could make claims, or *warrants*, that summarise our interpretation of the ball and what it means to individuals but with an inherent understanding that this is the best current interpretation and is subject to change.

Digital technologies could easily be considered as a positivist tools. They are, after all, physical devices which exist as physical objects in the real world independently of objects around them. At their very core they exist as pure binary devices, and can exist in only two states, a 1 or a 0. This digital nature is at the heart of the technology, and therefore could also be said to be at the heart of the digital space as outlined in Chapter 4. However, as Chapter 4 has also explored, the human architects of digital places have the capacity through their own building tools to imbue their own thinking into the places they create. They effectively embed their cognition into the digital places they make in a form in which it can provide autonomous interaction with occupants of that place, long after the original designer has left. As Hutchins (1995) argues, cognition is not simply in the head, but is distributed in the world around us, perhaps no more so than in the digital places which we visit or inhabit (White, 2011).

This duality, of a binary world operating under strict scientific rules, yet pre-scripted (quite literally) with autonomous human thought, raises something of a quandary for the researcher. From a positivist perspective there should exist at a certain level within the digital space rules and regularity whose functions could be extracted through study, yet through an interpretive paradigm the very fact that human thought is intertwined into the very same digital space in the form of digital places and digital objects suggests that any occupant of that space is as the same time engaged in a subjective interaction with the embedded cognition of other individuals, whether the original digital architect or any other synchronous or asynchronous users of the space as appropriate.

The current work contends that the positivist approach, effectively a form of technological determinism (Veblen, 1921), is flawed by failing to understand that the positivist component of this jigsaw - the hardware itself that pre-defines the limitations of any digital space that they might support - is inanimate and sterile without the human component, i.e. the software, that allows for the digital space itself. This software is, necessarily, socially constructed. It is a product of an individual's thinking, associating computer interaction with an intelligence derived from the computer itself is a misappropriation. The intelligence - or cognition - is not that of the computer, it is that of the computer designers. Their cognition is distributed into the system (Hutchins, 1995).

This thinking frames the level at which the current research is undertaken. It is not attempting to prove in a positivistic sense precisely what all digital technologies consist of, and all the invariants that they might contain. Nor is it trying to understand from an interpretivist approach the internal cognitive processes that might constitute an experience of an affordance. Instead it intends to explore how affordances are discovered and used within learning scenarios, and how the two ‘ends’ of affordance - intention and invariant - are located and activated within digital technologies and the individuals who use them. By studying emerging relationships within real learning scenarios it hopes to produce claims or “warrants” (Phillips, 2005) that might clarify how the theory of affordances can be used to align pedagogy and technology.

Research methodology

The second question this chapter addresses is the type of research methodology that is appropriate when undertaking educational technology research into affordances. The research approach chosen must fulfil a number of requirements in order to be accepted as rigorous enough for its intended community. Towne and Shavelson (2002) developed six guiding principles that they propose underlie all scientific inquiry, including education research:

- Pose significant questions that can be investigated empirically
- Link research to relevant theory
- Use methods that permit direct investigation of the question
- Provide a coherent and explicit chain of reasoning
- Replicate and generalise across studies
- Disclose research to encourage professional scrutiny and critique

These principles provide a useful frame within which to discuss the appropriateness of research methodologies to the current work. However, they can also highlight what is potentially historically missing from this form of inquiry, and hence suggest ways in which new research methodologies might expand on these principles. For example, they make no mention of any practical output from research, or of meeting any existing need from practitioners in the research field.

A critique that has been levelled against educational technology research specifically is that it can be too heavily based on correlation, that findings tend to be highly qualified with little transferability between learning scenarios, and with little deep understanding of the underlying processes that are taking place, i.e. where the computer is treated as causal black box (Oliver 2012). Sloman (2012) even goes so far as to liken educational research itself to a form of alchemy:

> "Alchemists did masses of data collection, seeking correlations. In the process they learnt a great many useful facts – but lacked deep explanations ... this correlation-seeking approach characterises much educational research."
>
> Sloman (2012)

Reeves argues that weaknesses within educational technology research are related to the approaches taken to date, and stem "from decades of an arguably flawed research agenda that has been both pseudoscientific and socially irresponsible." (Reeves, 2006, p.52). A pressure to publish coupled with a focus on traditional classroom/technology comparisons and specific media form analyses has produced research of little help to practitioners (Reeves, 2009) and often of "low quality" (Bernard et al, 2004).

These thoughts have striking similarities with James Gibson's experiences in his own research. Prevailing models of research into perception during his years studying the subject focused on laboratory situations where specific comparisons were made in controlled conditions, testing isolated perceptual qualities. At the time when he was writing the Ecological Approach to Visual Perception, the study of perception more widely was almost entirely limited to laboratory experiments:

> "The fundamental tendency of laboratory psychology had been (and for the most part still is) to control subjects' movements and intentions, a tendency that the development of computerised laboratory procedures had exacerbated."
>
> Reed (1989, p. 5)

Research was performed in laboratory situations, strictly controlled, with research subjects often held fixed in position in order for experiments to be run on their perceptions. Gibson argued that it was crucial for subjects to be able to move and express themselves more naturally, that studying them in such artificial conditions was necessarily limiting research progress.

This has echoes of Dewey's thinking on education. Dewey argued that learning came from experience, that it is a "continuous process of reconstruction of experience" (Dewey, 1938, p. 87). He also argued that learning was not only experiential but also relational, reminiscent of Gibson's relational approach to affordances, and that this was a specific problem when considering the "scientific method" of laboratory research:

> "Adaptation of the [scientific] method to individuals of various degrees of maturity is a problem for the educator, and the constant factors in the problem are the formation of ideas, acting upon ideas, observation of the conditions which result, and organisation of facts and ideas for future use. Neither the ideas, nor the activities, nor the observations, not the organisation are the same for a person six years old as they are for one twelve or eighteen years old, to say nothing on the adult scientist."
>
> Dewey (1938, p. 88)

Gibson's attitude to research, studying individuals in naturalistic settings in a relational and context sensitive manner, has a parallel in a relatively new and maturing methodology which focuses on just this type of design challenge - design-based research. This new type of methodology began with the design experiments/design research of Brown (1992), and has now gained a firm foothold within the educational technology research community (Parker, 2011). It has been "heralded as a practical research methodology that could effectively bridge the chasm between research and practice in formal education" (Anderson and Shattuck, 2012, p.1). Barab and Squire (2004), building on the work of Collins (1999), have produced a table which compares more traditional form of research with this new methodology. This table is shown below, as Table 5.1.

Category	Psychological Experimentation	Design-Based Research
Location of research	Conducted in laboratory settings	Occurs in the buzzing, blooming confusion of real-life settings where most learning actually occurs
Complexity of variables	Frequently involves a single or a couple of dependent variables	Involves multiple dependent variables, including climate variables (e.g., collaboration among learners, available resources), outcome variables (e.g., learning of content, transfer), and system variables (e.g., dissemination, sustainability)
Focus of research	Focuses on identifying a few variables and holding them constant	Focuses on characterizing the situation in all its complexity, much of which is not now a priori
Unfolding of procedures	Uses fixed procedures	Involves flexible design revision in which there is a tentative initial set that are revised depending on their success in practice
Amount of social interaction	Isolates learners to control interaction	Frequently involves complex social interactions with participants sharing ideas, distracting each other, and so on
Characterizing the findings	Focuses on testing hypothesis	Involves looking at multiple aspects of the design and developing a profile that characterizes the design in practice
Role of participants	Treats participants as subjects	Involves different participants in the design so as to bring their differing expertise into producing and analysing the design

Table 5.1: Comparing psychological experimentation and design-based research methods (Barab and Squire, 2004; based on work from Collins, 1999)

Reeves and others have also suggested that a design research approach, or what is now more commonly known as a design-based research approach, is the most appropriate methodology for researching educational technology (Reeves, 2006; Parker, 2011). Design-based research is in “a unique position to address the complexities inherent in educational technology research” (Reeves, 2008, p.35).

The design-based research approach aligns with the post-positivist methodological approach, in that it too aims to provide warrants for the effectiveness of a design approach, rather than a categoric black and white claim of the superiority of one approach over another. As Barab and Squire (2004) put it, design-based research:

> "requires providing local warrants for the effectiveness of the design work while simultaneously attempting to contribute to a larger body of theory."
>
> Barab and Squire (2004, p. 6)

Although design-based research is an evolving methodology, with no strict definition, researchers have identified a number of principles. Reeves (2006), for example, outlines three principles:

> "… addressing complex problems in real contexts in collaboration with practitioners; integrating known and hypothetical design principles with technological advances to render plausible solutions to these complex problems; and conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles"
>
> Reeves (2006, p. 58)

Anderson and Shattuck (2012) suggested the following five characteristics were hallmarks of a DBR approach:

- Using mixed methods
- Involving multiple iterations
- Involving a collaborative partnership between researchers and practitioners
- Evolution of design principles
- Practical impact on practice

Design-based research is a longitudinal approach to research, but also one that attempts to influence and change what it is being studied during that research. By setting out an initial plan, but then changing and modifying that plan during multiple iterations, the research attempts to produce practical outputs grounded in participants' actual experience.

Reeves (2006) summarises the approach in a 4 stage diagram that cycles back against itself in multiple ways. This diagram is depicted in Figure 5.1.

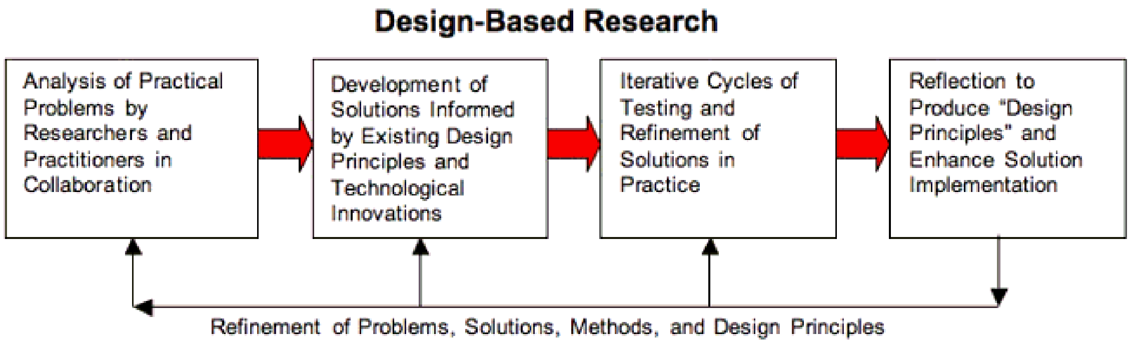


Figure 5.1: Stages of design-based research (Reeves, 2006, p. 59)

This framework can be aligned with the goals of this thesis. The *practical problem* addressed is how to use technologies effectively within learning. The proposed *solution* is to create a way of aligning technology and pedagogy based on affordances theory. *Iterative cycles* of design, testing and refinement are planned to create this solution, coupled with reflection to produce *stable design principles and implement a specific solution*. The present research therefore has taken a design-based research approach, setting the research in the real environments of learners whilst they are in the process of learning, rather than creating a synthetic situation for research, and aiming to produce practical outputs and outcomes through collaboration with practitioners.

Research design

The third question this chapter addresses is the research design that is appropriate when undertaking educational technology research into affordances. Maxwell (2005) proposes that any research design should cover five elements: Goals, Conceptual

Framework, Research Questions, Methods and Validity. He further clarifies the purpose of each:

1. Goals: Why is your study worth doing? What issues do you want it to clarify, and what practices and policies do you want it to influence? Why do you want to conduct this study, and why should we care about the results?
2. Conceptual framework: What do you think is going on with the issues, settings, or people you plan to study? What theories, beliefs, and prior research findings will guide or inform your research, and what literature, preliminary studies, and personal experiences will you draw on for understanding the people or issues you are studying?
3. Research questions: What, specifically, do you want to learn or understand by doing this study? What do you not know about the things you are studying that you want to learn? What questions will your research attempt to answer, and how are these questions related to one another?
4. Methods: What will you actually do in conducting this study? What approaches and techniques will you use to collect and analyse your data, and how do these constitute an integrated strategy?
5. Validity: How might your results and conclusions be wrong? What are the plausible alternative interpretations and validity threats to these, and how will you deal with these? How can the data that you have, or that you could potentially collect, support or challenge your ideas about what's going on? Why should we believe your results?

Maxwell (2005, p. 4)

This 'interactive' approach to research design is illustrated graphically in figure 5.2, showing the primary relationships between these elements.

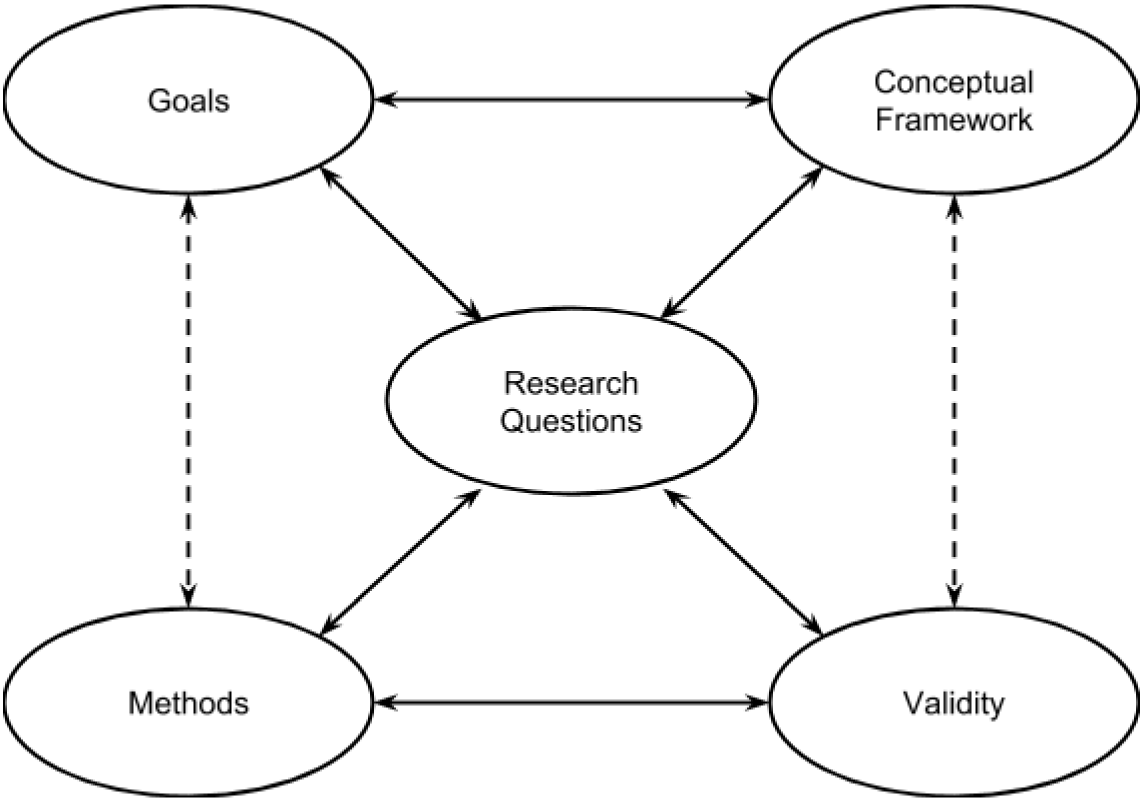


Figure 5.2: An interactive model of research design (Maxwell, 2005, p. 5)

Using Maxwell's model as a framework for the research design, each element of the present research design is described in detail, below.

Goals

As has already been discussed in Chapter 4, it has been proposed that those who grow up with technology are 'digital natives' (Prensky, 2001b), that they think differently because they have been using technology all their lives. This is a tempting concept, and it has had widespread acceptance, but there is little evidence to support the claim (Bennett et al, 2008). Indeed, some research appears to show that although young people such as undergraduates have grown up with technology, their use appears limited to specific websites and applications, and that they lack the ability to transfer their digital knowledge from one context to another (Somyürek and Coşkun, 2013). This raises a serious concern for those interested in how technology can be aligned with learning, in that the value of a specific technology from an educational perspective appears generally hidden from those most in need of it, i.e. the learners themselves.

Why might affordances be useful in educational technology research? The key to this question lies in a simple concept that is at the heart of theory of affordances, that an affordance does not change as the need of the observer changes. This means that knowledge of the specific *potential* affordances of a digital technology would allow those affordances to be actively designed into a learning scenario during the curriculum design process. As Day et al (2007) argue, technologies have *potential* affordances that need to be actualised by learners within learning contexts if they are to have an effect on the learning process. This activation is determined by the context in which the learners find themselves, as this drives learner intention.

Whilst acknowledging that affordances are personal, and that any affordance exists as a *relationship* between an individual and invariants in the environment (Chemero, 2003) - whether digital or otherwise - because humans are more alike than they are different, affordances for one individual are more often than not applicable to another. Individuals may need to *learn* an affordance - something which will be returned to later - but individuals from a similar background embarking on similar objectives, such as within learning scenarios, should be able to take advantage of similar affordances.

Gibson’s theory of affordance is based on earlier work by, amongst others, Kofka and his concept of "demand character" - what was present in objects that suggested what an individual could do with them. Crucially though in this theory the link between object and human is phenomenal, it exists only when the human needs it. In Gibson’s theory affordances remain, but what is attended to changes depending on the intention of the individual.

> “The concept of affordance is derived from these concepts of valence, invitation, and demand but with a crucial difference. The affordance of

> something does not change as the need of the observer changes. The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived."
>
> Gibson (1979, p. 138)

This permanence of an affordance that is particular to the theory of affordances when contrasted with more phenomenological perspectives should enable specific affordances to be designed into a learning scenario in order to meet specific pedagogic objectives. Theoretically it allows a form of pedagogic and technologic alignment in curricular design, and as Higgins, Xiao and Katsipataki (2012b) have noted, if technology can be effectively aligned with learning then benefits should result. The overall goal of the study is therefore to explore how affordances might be used to align pedagogy and technology.

Conceptual framework

The conceptual framework that the research is set within combines the basic outlook of ecological psychology with a situated constructivist perspective of learning.

The key concept of ecological psychology is affordance, Gibson's attempt to explain how individuals recognise meaning in the world around them. Affordances exist as a relationship - i.e. they are something that exists both in the world and in the individual. As Hammond describes it, affordance is:

> "a relation between an organism and an object with the object perceived in relation to the needs of the organism."
>
> Hammond (2010, p. 205)

As has been described in Chapter 3, affordance has two characteristics that are most relevant from a research design perspective. Firstly, in order for an affordance to be actualised there must exist intention or need in the individual for which the affordance exists. As Greeno (1994) summarises:

> "Affordances are ... preconditions for activity. The presence in a situation of a system that provides an affordance for some activity does not imply that the activity will occur ... motivation to engage in some action is related to what the agent is doing at a more general level."
>
> Greeno (1994, p. 340)

Secondly, that there are invariants in the world, and these are 'picked-up' by individuals and realised in the form of affordances, individualised or personalised meanings if you will. These two pillars of affordance, intention within the individual and invariants as a key 'end' of an affordance embedded in that world, take on a new meaning when considering digital places. It provides us with a scenario whereby one of the key pillars of affordances - the invariants - are now held within digital space and a specific digital place.

Theoretically invariants in digital spaces are created from nothing and therefore should have little parallel with real objects. A computer programme, and any subsequent experience of a digital space that arises out of that computer programme, does not exist until lines of code are written. In practice, however, digital spaces and digital entourage (i.e. the environment or surroundings) are created by designers through *simulations* of objects and experiences from the real world, and therefore attempt to provide the same affordances as can be experienced in the real world. A digital document, for example, attempts to maintain borders, margins, and the basic ratio of a printed piece of paper. The word processor provides the same 'cut' and 'paste' functionality that was the bread and butter of publication design long before computers became involved in the process. Presentation software allows the creation of slide after slide of text and imagery, as if producing acetates for use on an overhead projector.

Buttons are given shadow and highlighting to provide the illusion of illumination and hence being raised above or sunk into a screen, suggesting that they can be pressed. We use *metaphors* to extend affordances from the real space into the digital space, copying the invariants from real space - such as the way light falls creating shadow or texture gradient - into the digital places we create.

The argument has been made, however, that digital space is not bounded by real world constraints in the same manner as objects in real space are. Digital spaces, and therefore digital places, are only simulations - and as such the digital environment (and objects within it) can be created, manipulated and experienced in novel ways. The predisposition to design digital technologies as *accurate* simulations of real world or historical objects, i.e. mimicking perfectly their real space counterparts, may in fact be disguising or at least obscuring unique benefits of digital technologies that lie in new invariants and therefore new affordances. As Ciolfi (2011) argues, design of digital spaces should focus on place experience and augmentation as opposed to simulating the real world:

> “Providing the possibility for novel interactions in the physical world [via digital technologies], rather than creating virtual replicas of it”.
>
> Ciolfi (2011, p. 221)

The situated perspective of learning argues that knowledge is “a product of the activity and situations in which they are produced” (Brown et al, 1989, p. 33). When considering digital technologies as space and place, the manner in which this space/place is designed and used would therefore have a direct impact on learning from a situated perspective. The framework outlined suggests that how learners identify affordances within digital places and apply them to support their own learning is a crucial component to understanding how to align pedagogy and technology. Given the scenario above - where one ‘end’ of affordances, invariants, is suspended in a digital space where possibilities for novel experience may be present, the key question is therefore how can we identify these possibilities in a structured and rigorous manner.

Chapter 3 has outlined an understanding of affordances as a trinity, linking intention and invariant through the ‘space of possibilities’ which is affordance. Chapter 4 has adopted a situated perspective of learning, but crucially one that includes not only the real environment but also the digital environment. It locates one end of the affordances trinity, that of invariants, within this digital environment. Together this provides the conceptual framework within which the research is operating; the affordances trinity as a “tool to structure inquiry” (Dewey, 1916, from Antonenko, 2014, p. 5), within a situated view of learning, located in digital spaces and places.

Research questions

At the heart of any research study lie its research questions (Maxwell, 2005). This central role for the research questions is illustrated graphically in figure 5.2, showing how the research questions themselves relate to other key components of the research design. Research questions to a very large extent define the study and how it is carried out, and are “one of the decisive factors in its success or failure” (Flick, 2009, p. 137). However, they are not necessarily cast in stone, and arguably should evolve as the research evolves.

Chapter 1 outlined three broad goals for the research, specifically:

- To clarify conceptions of digital space and place, in relation to existing theories, in particular theories that explore concepts of environment
- To explore invariant aspects of digital space and place, and what consequent affordances might be made available as a result of these invariants
- To understand how potential affordances might be designed into learning scenarios, and the impact of this on learners

Chapters 2, 3 and 4 have given some clarity to these goals, allowing them to be rephrased now and summarised as a single overarching research question:

- Can the theory of affordances provide the basis for a theoretical framework through which digital technologies can be aligned with pedagogic goals?

Such a broad question cannot easily be explored within educational contexts however, and hence it needs to be further broken down into more distinct and manageable research questions. Chapter 3 explored the origin and current interpretations of affordance, and proposed that a return to Gibson's original definition may lead to a clearer understanding of its meaning. It also proposed that the two concepts of intention and invariant are key to the overall affordances concept, as they form the two 'ends' of an affordance in practice, and therefore should not be excluded. These notions provide the basis for the first two research questions:

- What role does intention/need play in the detection/use of affordances?
- What invariants within digital technologies make affordances possible?

Chapter 3 concluded by suggesting that it was what individuals received back from an interaction which lied at the heart of an affordance, the "meaningful consequences" of actions rather than the actions themselves. We do not flick a light switch simply because it can be flicked, we flick a light switch because we want light, it is a transactional process. This notion provides the basis for the final research question, which is a deliberate twist on the definition of affordances as put forward by Gibson (1979). If affordances are what things in the world "provide or furnish", then surely we must be receiving something back from these things as we interact with them, the third question is therefore:

- What do learners receive from a digital technology, when used in an educational context?

Methods

As design-based research is an evolving methodology, there are no strict definitions as to how it should be carried out in practice (Joseph, 2004). Although Reeves (2006), Plomp (2007) and others have suggested overall structures, they have not provided guidance over the distinct steps that need to be designed and carried out. Alghamdi and Li (2013) note that Instructional Technology PhD students at the University of Georgia (2006), however, have produced a nine step plan which specifies how design-based research might be planned, or at least how it might begin, steps “that should be taken into account when conducting design-based research” (Alghamdi and Li, 2013, p. 5). These steps, and accompanying explanatory text as written by the students, are listed in table 5.2.

1. Begin with a meaningful problem	“Perhaps the most essential differentiating aspect of design-based research is its emphasis on addressing meaningful problems faced by teachers, learners, and others. Design-based research requires an enormous long term effort by all involved and thus it should not be targeted on trivial problems.”
2. Collaborate with practitioners	“To begin with, researchers need to be actively involved in a real world design project collaboratively with other participants such as instructional designers, curriculum developers, teachers and evaluators when conducting design research. Two distinguishing features of the process of design-based research are being grounded in real-world settings and working closely with other stakeholders in those settings.”
3. Integrate robust theory about learning and teaching	“The whole process of design research is guided by the most robust existing theory about teaching and learning. Through the process of design-based research from design to enactment, to analysis, and to redesign, researchers hope to reveal what works, what do not work, and how it works under certain conditions in a specific context. Ideally, the researchers will continuously modify designed interventions and apply them to another setting for generating design knowledge or principles grounded in broader contexts.”
4. Conduct literature review, needs analysis, etc. to generate research questions	“Like other research methodologies, design-based researchers conduct a critical literature review and needs analysis to identify problems or gaps, thereby generating research questions (Bannan-Ritland, 2003; Joseph, 2004).”

5. Design an educational intervention	“To begin the process of solving the meaningful problem with which the design-based research initiative began, an educational intervention grounded in a robust theoretical framework is designed and placed in real-world contexts for testing. Ideally, design-based research can narrow the gap identified by the needs analysis by redesigning the interventions and/or refining the theory-based design principles.”
6. Develop, implement, and revise the design intervention	“Development of the design intervention is interactive with and responsive to iterative stages of formative evaluation and re-designs. From the initial design of educational intervention, a development team constructs and articulates a prototype, and develops a more elaborative intervention based on feedback given from evaluation of the intervention in practice (Bannan-Ritland, 2003). The iterative and responsive process may involve multiple design-test-revise cycles.”
7. Evaluate the impact of the intervention	“Design-based researchers gather data to reveal how well the intervention addresses the problems and how well the selective theories explain the learning process and outcomes. Evaluation of the design is formative in that the data may require the researchers to refine the initial design theories and, in turn, to develop a more detailed design intervention accordingly (Collins et al., 2004). Over time, the more fully developed intervention will be implemented in the same setting, other similar settings, and broader settings so that researchers can describe the interplay between design theories and multiple practices.”
8. Iterate the process	“Through the successive refinement cycles, design-based research has a potential not only to construct more robust, applicable designs over time but also to generate well-supported design theories about learning and instruction (Collins et al., 2004), thereby resulting in deeper understanding of complex learning environments (Cobb et al., 2003).”
9. Report DBR	“Finally, it is important to report design-based research in the forms of in-progress reports, a series of interim reports, journal articles, and books because it is likely to evolve over time (Collins et al., 2004; Reeves, Herrington, and Oliver, 2005).”

Table 5.2: Steps for conducting design-based research

As the Instructional Technology PhD students themselves comment, these steps are not necessarily chronological and “often occur simultaneously or sometimes in a different order”. They do however provide a potential framework within which to clarify the specific methods the current research is using within its design-based research approach.

These steps have been used to produce a new design-based research “spring” model, which visualises whereabouts in the overall design-based research process each of the steps is most prominent. This helps to understand the timeframes within which different steps of the process should have the most focus within the overall research. This model is show in Figure 5.3, below:

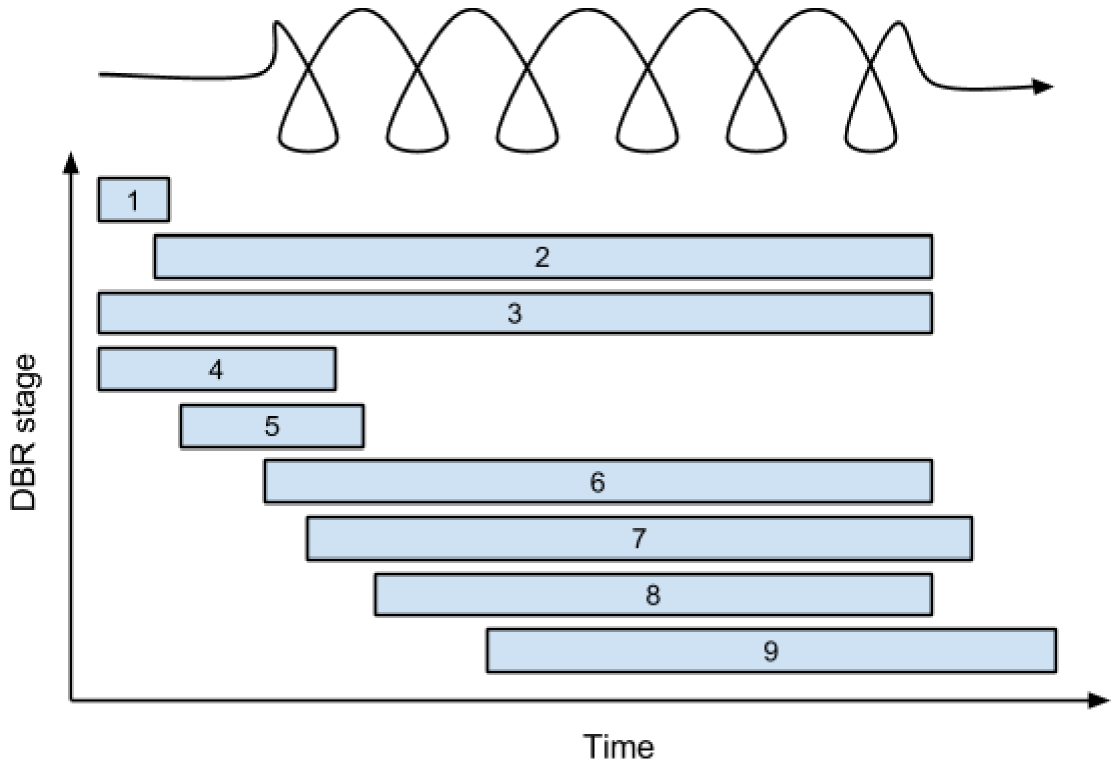


Figure 5.3: The "DBR Spring" model aligning process steps over time.

1. Begin with a meaningful problem

Chapter 2 explored the lack of progress within educational technology research (Cuban 2001; Clark 2001), given the huge investment in this field and the perceived potential of digital technologies to transform learning. How digital technologies might be aligned with teaching and learning is therefore a very real and widespread problem. Alghamdi and Li (2013) note that the design-based research approach can be used to help to develop existing theories, and the theory of affordances has been proposed as one which has the potential to create this alignment. The meaningful problem is therefore how to align technology with pedagogy.

2. Collaborate with practitioners

A key part of a design-based research approach is collaboration, not only with educators, but also with other key stakeholders from the learning process. As Reeves puts it, “design research requires the collaboration of academic instructors and other staff of diverse stripes” (Reeves et al, 2005, p. 106). The research therefore sets out to engage directly with multiple stakeholders from the broader educational context, i.e. not just teachers and learners, and gather data from a wide selection of those involved. It aims to build long term relationships with practitioners, as these practitioners should be seen as co-designers within the overall process (Barab and Squire, 2004).

3. Integrate robust theory about learning and teaching

According to Greeno et al (1992) “learning is the process by which knowledge is increased or modified”. How this process actually occurs in practice is currently debated between various learning theories, and Greeno et al describe three predominant perspectives. In the behaviourist/empiricist view, learning is concerned with building new associations, of linking something in the world with an appropriate response, where the strength of that linking can be reinforced or weakened through repeated exposure. The cognitive/rationalist perspective centres on schema, complex mental patterns which frame an internal conception of an external set of events or links. Learning is seen as self-constructed changes to these schema as a result of experience and reflection. The situative/pragmatist perspective contends that learning is primarily through others, through communities, that knowledge is distributed and hence learning happens through being embedded within the place and the people where that knowledge is held.

Within each of these learning perspectives there runs a common thread that learning is experiential, that this process through which knowledge is increased or modified relies heavily on personal experience. Though not a new concept (Dewey, 1938), it has been suggested by some that experiential learning or “learning by doing” unites disciplines and theories alike (Laurillard, 2012a). Laurillard uses the term constructionism to summarise this aspect of learning perspectives. This frames the theoretical approach the current research is undertaken under, learning as individually constructed through experience in situated practices - learning as a process of “becoming attuned to constraints and affordances of material and social systems with which they interact” (Greeno, 1992, p. 17).

4. Conduct literature review, needs analysis, etc. to generate research questions

Chapter 3 has explored the current thinking on affordances, and has focused on how affordances are currently interpreted. It has argued that the focus on action possibilities is inconsistent with Gibson’s original conception, and that the role of two crucial aspects of affordances theory - intention and invariance - have not been well explored. This provides both the problem for the research, in terms of the interpretation and hence application of affordances, as well as the gap in the current literature, in terms of intention and invariance which the research intends to explore.

5. Design an educational intervention

The design-based research approach is interventionist, the research “aims at designing an intervention in the real world” (Van den Akker et al, 2006, p. 5). It focuses on taking an existing learning scenario and intervening in that scenario is a structured way in order to study the effect of that intervention. That produces design principles and other tangible outputs which are then fed back into further design iterations in order to produce robust and grounded outputs (Wang and Hannafin, 2005). The current research therefore aims to identify suitable existing learning scenarios where an intervention would be possible.

Negotiations were carried out with a local school, referred to within this thesis as School A, in early 2009 in order to identify suitable participants to work with and learning scenarios that might be suitable for an intervention. This school was approached for three core reasons:

- Existing personal contacts with the school, which facilitated access to key individuals and provided a deeper understanding of existing practices than would otherwise be immediately available.

- Proximity of the school to the researchers own location. As a design-based research approach relies on close working with practitioners, being able to access the school simply and quickly is a key requirement.
- Familiarity with, and widespread use of, digital technologies. As a school with a specific focus on media and arts, School A had an existing affinity and experience with digital technologies.

The school responded positively to requests for research collaboration, and an initial schedule was designed for the approach and to implement the first iterations. An intervention was planned for classes preparing for an oral test of their French knowledge. The pedagogical challenge this presented, combining a theoretical understanding with a practical demonstration, fitted the overall research design well. A specific piece of digital technology was identified that had the capability to provide a rich learning environment within which to develop both theoretical and practical learning. This learning environment was then combined with their existing curriculum, with the intention of extending and augmenting the learning possibilities when compared with the traditional learning environment. This intervention is described in full in Chapter 6.

6. Develop, implement, and revise the design intervention

The initial research design involved two cohorts of learners within formal education studying similar materials, and introduced a new digital environment for both cohorts within which the bulk of their studying would be undertaken. The learners use of this digital place would be studied over an extended period of time in relation to the three research questions, and changes to the way in which the place was used would be introduced over time in response to analysis of the data gathered, in order to build an initial design framework linking intention, invariant and the ‘space of possibilities’ of affordance linking these two. Iterations would be generated for the two cohorts independently, with data from both re-fed back into the design over time. This would create iterations for analysis and refinement of design principles underlying the design framework. As formal education tends to be organised on a termly basis, the iterations were planned to be carried out on a termly basis.

This research design process is shown graphically in figure 5.4, below.

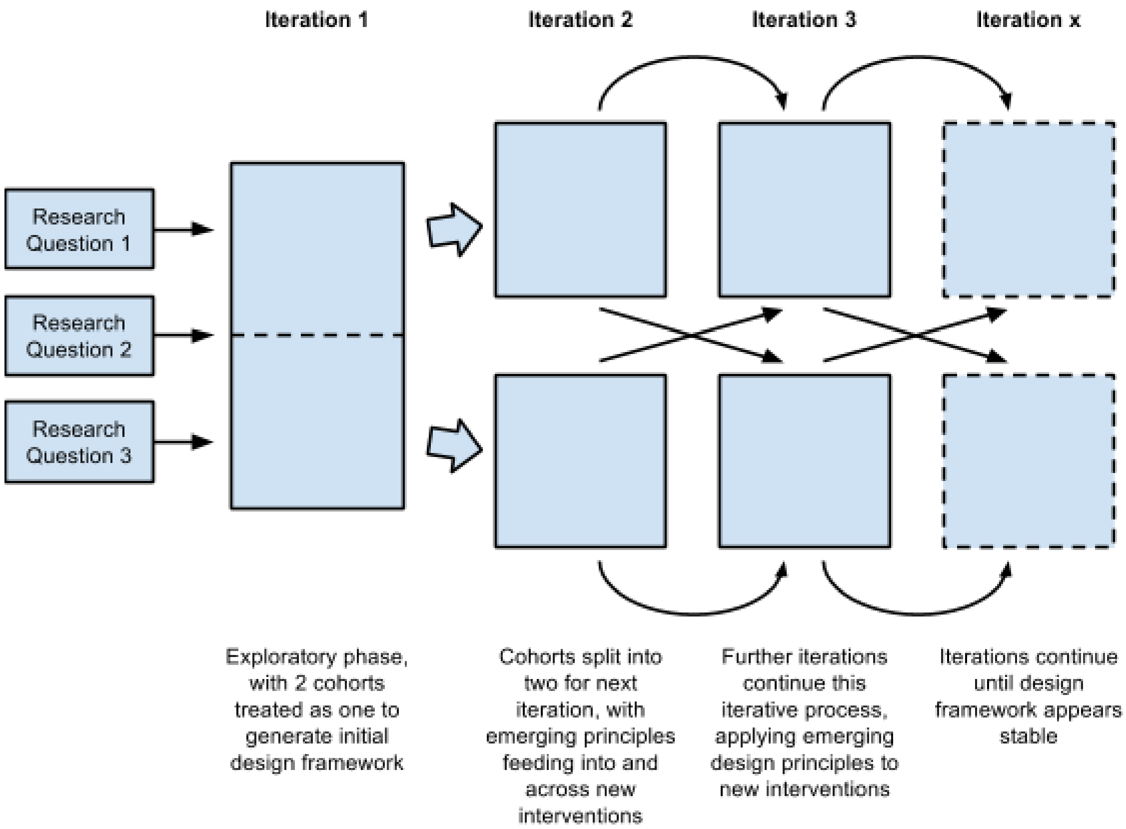


Figure 5.4: Initial research design (School A)

The initial exploratory phase of this research design took place at the beginning of the 2009/10 academic cycle, and data was collected over sixteen classes with the two cohorts from Iteration 1. This is described in full in Chapter 6, along with analysis of the data gathered. Further iterations with School A, however, could not be completed. The research was undertaken on a part-time basis, with the agreement and support of my employer. However, organisational and staffing changes within that organisation precluded any further involvement with the initial research cohorts after the 2009/10 autumn term and therefore any further iterations with these groups. This presented a serious challenge in terms of continuing the research. Although the school was keen to continue the partnership, it was no longer possible to secure the necessary time to carry out any further research with School A.

After spending some time reviewing options, a further opportunity to continue the research in a new context presented itself in 2011. A 3 year project at the University of Exeter, the Collaborate project, was setting out to explore the relationship between employability, technology and assessment in a higher education setting, and was looking for a project manager to run and manage the project. Whilst the focus of the project was on moving assessment practices to more authentic and employer and employment-led ways of working, the project had a number of key elements which suggested it could also serve as a vehicle through which to continue the research:

- A strong partnership/collaboration element, working with multiple practitioners from across the institution in real learning scenarios
- A specific requirement to align existing and emerging digital technologies with teaching and learning practices
- The need to work iteratively across the institution, with evaluation of interventions implicit both as ongoing formative evaluation and with regular, defined summative evaluation points
- A requirement to produce both tangible outputs and documented outcomes

These key requirements map well with the overall design-based research approach, as documented by many authors (Design Based Research Collective, 2003; Reeves et al, 2005; Van der Akker et al, 2006). It was envisaged that the initial design framework which emerged from the work at School A could serve as a foundation for research at Exeter, and provide a basis for new iterations in a different context. There would be the opportunity to explore the research question focused on intention through the work on employability and assessment, the opportunity to explore the research question focused on invariants through the need to bring in digital technologies, and the opportunity to explore the emerging affordances through the alignment between these two. I therefore applied for, and was offered, the position of project manager and was able to continue the research within this new context. A new schedule building upon the existing research, but based within the new context, is shown below in Figure 5.5. The detailed design and corresponding analysis of the data collected during this research phase is documented in full in Chapter 7.

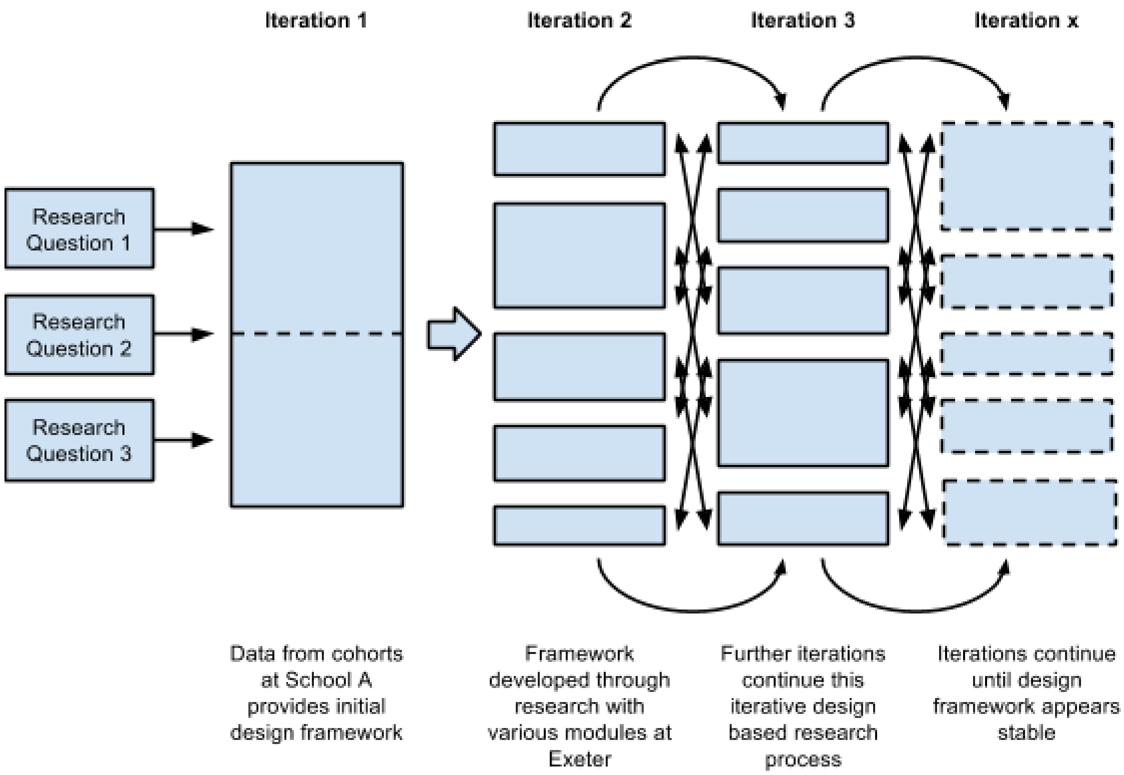


Figure 5.5: Updated research design (University of Exeter)

7. Evaluate the impact of the intervention

This step recommends the evaluation of the impact of an intervention, with data gathered and analysed with a view to improving the overall design. It differs from traditional research approaches in that it is an ongoing formative process as opposed to a summative process (Collins et al, 2004). The purpose of the evaluation is not to evaluate the end product, to measure in a summative way how well the product might meet a pre-set criteria, for example, but to inform the design process and hence improve the design outputs and outcomes.

Initial research with School A used a combination of student and staff evaluation tools during each learning session, in order to build a comparative and well-structured chronological pattern of experience. In addition the use of digital technologies to automatically record student/computer interactions allowed me to gather data in real time during the sessions, in the form of research notes and memos. These are documented in full in Chapter 6.

Continued research at Exeter used regular project team meetings to evaluate progress and the results of collaboration with practitioners to produce ongoing informal evaluation. Four formal reports were written summarising the progress of the research, and an academic paper summarising one iteration was written and accepted for publication (Osborne, Dunne and Farrand, 2013). This paper won the award for best research paper at the conference where it was reported. More formal evaluation sessions were designed and implemented to evaluate the impact of interventions; details of both these informal and formal evaluation are documented in full in Chapter 7.

8. Iterate the process

At the heart of a design-based research approach lie iterations, repetitions of interventions in real learning scenarios, where findings from previous interventions are integrated into new interventions in order to refine and improve practice. This process, and how it has been designed into the research, can be seen graphically in Figures 5.4 and 5.5.

Although these figures only show iterations of interventions, there exists an implicit unstated parallel iterative process of design improvement. Steps 6, 7 and 8 together create a cycle of process improvement through design, what might be termed micro-iterations, where design products such as frameworks are actively enhanced through each iteration, and reapplied to specific contexts of learning. This can be seen graphically in the “DBR spring” diagram earlier, Figure 5.3, and is discussed in more detail in Chapter 7.

9. Report DBR

A recommendation emerging from various authors, as documented by Instructional Technology PhD students at the University of Georgia (2006), is that design-based research should be reported on a regular basis in order to capture and develop ideas as they emerge from the design process. In order to produce design frameworks and methodologies (Edelson, 2002) that can have value beyond the research itself, the design process itself must be captured.

The project approach of the work at Exeter in particular was ideally suited to these needs to report DBR. By following a strong project approach, including the need to produce interim reports, to report to a steering group, and to disseminate research with stakeholders both inside and outside the institution on a regular basis, the design process was captured in detail, and hence provided a rich set of data for retrospective analysis, an essential part of design research (Edelson, 2002). This reporting and analysis is discussed in Chapter 7.

Validity

A key requirement for any form of research is that it should be valid, i.e. that it should measure what it purports to measure (Cohen et al, 2000). Whilst many specific forms of validity might be discussed, we take Maxwell’s (1992) advice, and are cautious not to be swayed too much into a positivist frame of reference with regards to validity. As discussed earlier in this chapter, the overall stance of the research is post-positivist, and hence it is attempting to find evidence to support claims or 'warrants' for what is observed rather than to try to 'prove' that something is or is not true. Nevertheless, several specific choices have been made in order to try to improve the overall validity of the research, which are detailed below.

Hawthorne Effect

A key concern for the type of research in question, where those involved are aware that they are being focused on as research subjects, is what has become known as the Hawthorne Effect (Roethlisberger and Dickson, 1939). This describes the counterintuitive notion that the very presence of the researcher, and the attention that they focus on their subjects, can create positive effects in itself seemingly as a desire to impress or please. Although the series of experiments that gave rise to the term has been shown to be more complex than this simple interpretation (Brown, 1992), it is nevertheless a concern that the attention focused on the subjects may bias the results. It has been noted that this is a particular problem for design-based research approaches (Anderson and Shattuck, 2012), as researchers work closely with the research subjects and actively attempt to intervene within learning processes. In order to militate against this, it was decided to introduce two specific methods.

Firstly, the use of small 'Flip' video cameras with tripods as a central data collection tool, which should be a relatively minor distraction. Not only should their small size reduce the indication that any observation was in progress, but also any indication on the device itself that it was in operation - e.g. the red light on the front which would normally be illuminated - was disabled. Note that this was in no way an attempt to covertly film participants; it was done in order to lessen the ongoing distraction that the light might cause those under observation. As will be explained later in Chapters 6 and 7, all participants were specifically asked whether or not they were happy to be filmed in each observation session, and they were told what would be done with any recordings, in order to meet the broader ethical requirement for informed consent.

Secondly, multiple sessions were set with the subjects in the same location and doing the same task over a number of weeks. The intention behind this planning was that subjects would become accustomed to the situation, and it would become uninteresting and standard for them, reducing any potential researcher effect.

Motivation

One of the most clearly researched benefits for using digital technologies in education is that of enhancing motivation, and there seems strong evidence that increased motivation increases learning (e.g. Dickinson, 1995). However the purpose of the present phase of research is to try and identify underlying intention, invariants and consequent affordances of digital technologies in a learning scenario, not to study motivational effects. Indeed, motivation could potentially skew the results by promoting a false positive effect, i.e. instead of the specific alignment of technology with pedagogy causing an effect, it would simply be the motivational effects of the technology alone causing the effect. As such it is important to try and reduce the motivational effects of the digital technology in order to maintain the focus on emerging affordances. It was anticipated that the large number of sessions using a repeated formula would be sufficient in reducing motivational effects.

Triangulation

Triangulation is an attempt to confirm the validity of the research data by using multiple methods to investigate a phenomenon (Krathwohl, 1993). By varying time, location, participants, methods, and the researchers who are involved, the possibility of unintentional bias or skew in the results is reduced. In the current research, triangulation is improved through using multiple sources of data (Yin, 2003), i.e. multiple classes, with different learners and different teachers, and selecting different learners from each research session for detailed observation. There is no attempt to follow individual learners, instead data is gathered anonymously and synthesised as a whole to try and identity intention, invariant and resulting affordances.

Creswell highlights that triangulation can be achieved through various methods, and it is suggested that the proposed “concurrent triangulation strategy” (Creswell, 2009, p. 213) may be of particular interest for design-based research studies, as it focuses on the simultaneous use of quantitative and qualitative methods to try and triangulate and cross-validate data. The use of mixed methods has already been highlighted as a feature of design-based research (Anderson and Shattuck, 2012), so this sits well with the present design. Mixed methods for evaluation were designed for both the research at School A and for the research at Exeter in order to improve triangulation; the specific nature of each is detailed within their respective chapters.

Reporting design-based research

An idea central to scientific inquiry is that of replicability, yet this poses a particular problem when considering design-based research due to its inherent “complexity, fragility, messiness” (Barab et al, 2008). Design-based research is embedded in practice, it is intertwined in a cultural context which is difficult if not impossible to replicate, and hence it can be challenging for other researchers to replicate the findings (Hoadley, 2002).

These issues have a direct effect on the reporting of design-based research. Collins et al (2004) recognised that the conventional structure for reporting research - background, method, results, and discussion – may be unsuitable for reporting design-based research, as the approach “reconceives the experimental process”. They instead proposed five sections as an overall structure for reporting a design-based research methodology:

- Goals and elements of the design
- Settings where implemented
- Description of each phase
- Outcomes found
- Lessons learned

These 5 sections provide one possible method for reporting the current research, and map well with the nine steps which "should be taken into account when conducting design-based research" according to Alghamdi and Li (2013, p. 5), which has been used a framework for the overall research design as outlined earlier in this chapter.

Design narrative approach

Hoadley (2002) recommends that those undertaking design-based research should report it using a 'design narrative' approach, defining narrative as "a structure for conveying a series of related events, a plot." (Hoadley, 2002, p. 454). How to report the overall process that has been undertaken during design-based research has been identified as a key issue that it is important to convey to other researchers who may wish to replicate it (Barab et al, 2008). Rather than trying to present a polished summary, both Hoadley and Barab suggest that a design narrative exposes this process, allowing others to understand how a design has changed over time and adapted according to how it has worked in practice.

> "In the context of design-based research, we must endeavor to meet the challenge of replicability by adequately describing our research."
>
> Hoadley (2002, p. 454)

The design narrative approach differs from the more traditional "Introduction, Methods, Results, Discussion" model of reporting research, in that it places more emphasis on the history and evolution of the design process. It attempts to describe how a design has come into being, not simply report on the effects of a design in practice. As Hoadley summarises, detail about the particular role that technology has played within a research project can often be too opaque within traditional reporting structures to be of much value to other practitioners:

> "Consider how infrequently educational technology research (even some CSCL research) carries this type of description; the usual study presents a technology fully formed as if it had risen from the oceans like Venus herself; describes, at best, little of how the technology was introduced into the research setting; and may not even describe how the technology was used before judging its "effectiveness" in learning by means of some (possibly unrelated) post-test."
>
> Hoadley (2002, p. 454)

Although Hoadley suggest that design narrative creates a structure for conveying the experiences of a design-based research project, he does not suggest any *formal* framework that might be copied or used, no headings or sections that might be duplicated or used as a basis for similar stories. By combining the thinking of Hoadley (2002), Collins et al (2004), Barab et al (2008) and Alghamdi and Li (2013) the current research has derived a broad structure for the design narratives in Chapter 6 and Chapter 7 which allows for some formality of approach, but which still gives sufficient breadth to allow a narrative to continue. This broad structure is based on the following three sections:

- Context: Who was involved in the research, and where was it located? Why were both chosen, and how were they involved?
- Intervention design and implementation: How as the design envisaged and how was it implemented? What research instruments were developed? What practical changes were intended?

- Outcomes and analysis: What happened during the research? What did analysis of the data show? What impact did the research have on the participants?

Through this three part structure design narratives are presented in Chapter 6 and Chapter 7 which describe the research process at both School A and the University of Exeter.

Design principles and design frameworks

Design principles

One of the hallmarks of a design-based research approach is that it should produce design principles, guidance that emerges from the research summarising key findings in a manner which allows them to be reapplied in other educational contexts (Brown, 1992; Collins, 1992; Reeves, 2006). Design principles attempt to “bridge the gap” between theory and practice, suggesting concrete ways in which new educational interventions might be designed based on previous design research (Wang and Hannafin, 2005).

These design principles do not come into being fully formed, but are part of the iterative process, and are intended to be refined over time both within the research and beyond it, as Bell, Hoadley and Linn (2004) describe:

> “Much in the way design principles or patterns in architecture do not fully determine the design of a house but rather can serve to guide the process in the hands of a skilled architect ... researchers view design principles as an intermediate step between scientific findings, which must be generalized and replicable, and local experiences or examples that come up in practice.

> Because of the need to interpret design-principles, they are not as readily falsifiable as scientific laws. The principles are generated inductively from prior examples of success and are subject to refinement over time as others try to adapt them to their own experiences."
>
> Bell, Hoadley and Linn (2004, p. 83)

How design principles are articulated depends on the context. Van den Akker (1999) has described design principles as heuristic statements, and suggests that they can be formatted using the following structure:

> "If you want to design intervention X [for the purpose/function Y in context Z], then you are best advised to give that intervention the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis], because of arguments P, Q, and R'."
>
> Van den Akker (1999, p. 9)

Bell, Hoadley and Linn (2004) suggest that different *types* of design principle should be created, based on four different categories, which they define as:

- General Cognitive Principles: these tend to be related to wider research in psychology and learning, and concern understandings of memory, skill, etc. They therefore have an implicit relationship to cognitive theories of learning, which may place them somewhat outside the ecological and situated view explored in the current work
- Metaprinciples: these are derived from many research initiatives, and tend to be stable and applicable in multiple contexts
- Pragmatic Pedagogical Principles: these typically emerge from research such as that currently being undertaken, and can be linked to an overarching metaprinciple. They are usually applicable across contexts

- Specific Principles: these tend to be limited specific to the context in question, but may also apply within similar contexts

They do not, however, suggest such a formal structure as Van den Akker. The design principles they give as examples are simpler statements, e.g. “make thinking visible” (Metaprinciple) or “generating connections between ideas” (General Cognitive Principle) (Bell, Hoadley and Linn, 2004, p.81-82).

Van den Akker’s (1999) heuristic statements would appear to be a strong method for writing a design principle, and Bell, Hoadley and Linn (2004) provide a typology which would align any principles from the current research with other work. The goal of the research is therefore to identify design principles combining these two approaches.

Design frameworks

Whilst a common aim of design-based research is to identify design principles, a set of “design guidelines for a particular class of design challenge” (Edelson, 2002, p. 114), principles by themselves can be difficult to apply in practice. As Dewey noted:

> “... all principles, by themselves are abstract. They become concrete only in the consequences, which result from their application."
>
> Dewey (1938, p. 20)

Dewey argues that “There is no such thing as educational value in the abstract.” (Dewey, 1938, p. 46). Taking a situated view, his work on education and experience suggests that education has to be contextualised to the individual and the situation in order to be meaningful. It could be argued that such a perspective is incompatible with the notion that the affordance of a specific technology might be summarised in a single design principle, regardless of context.

Edelson (2002) argues that principles are most useful when aligned into a design framework, that design principles can lead to more concrete and applicable products from the design-based research process, in the form of design frameworks. The concept of the design framework is that design principles are framed together to create practical tools for a specific design scenario. The current research therefore aims to produce not only design principles, but to contextualise these within a wider design framework.

Defining 'success' criteria

An acknowledged problem with a design-based research approach is how many iterations are necessary, or perhaps to put it more succinctly, how to know when to stop. The iterative nature of design-based research, and its focus on continuous improvement over time, can lead to never ending cycles and ever more iterations. Dede (2004) addressed this issue directly, and proposed two specific points regarding defining success criteria:

- Separate design from conditions for success by ensuring that the latter are present in the pilot implementation
- Determine what constitute reasonable criteria for "success" in declaring a design finished

In the present context, there was no planned pilot implementation, which makes point one difficult to implement. The School A stage of the research could be considered as a pilot, but this stage was intended to be broad and deep, both in terms of participants and in terms of technologies, in order to create an initial large pool of data within which to focus. As such it would have been very difficult to build into this part of the research success criteria. Dede's second point provides a more useable point of reference in trying to establish the criteria to stop iterating.

Reeves (2006) proposes a chronology for design-based research, using four stages:

- Phase 1: Analysis of practical problems by researchers and practitioners in collaboration
- Phase 2: Development of Theoretical framework solutions informed by existing design principles and technological innovations
- Phase 3: Iterative cycles of testing and refinement of solutions in practice
- Phase 4: Reflection to produce ‘design principles’ and enhance solution implementation

This chronology provides the overall goal of a design-based research approach, that of producing ‘design principles’ and solutions. Herrington et al (2007) explore this further, and propose three distinct outputs that should be the result of Reeves phase 4:

- Scientific outputs: Design principles
  “The knowledge claim of design-based research ... takes the form of design principles ... that can inform future development and implementation decisions.”
- Practical outputs: Designed artefact(s)
  “... the product of design is viewed as a major output . Design artefacts in this field may range from software packages to professional development programs.”
- Societal outputs: Professional development of participants
  “... a design-based research project ... enhances the professional development of all involved.”

Together these three forms of output can be used to create criteria against which the current research can be measured, defining ‘success’ and informing the ongoing research as to when ‘enough’ research has been undertaken. These criteria are defined as follows:

- Scientific outputs: Design principles

  Principles are stable, in that further iterations do not suggest further changes to them should be made
- Practical outputs: Designed artefact(s)

  Products are stable, in that they are recognised by peers as having practical value outside of the research itself
- Societal outputs: Professional development of participants

  Participants reflect positively on their experiences within the research

Ethical considerations

Ethical issues have become more prominent in the 21st century, partly due to a wider appreciation in the general populace and increased sensitivity due to various scandals (Flick, 2006). Working with school children in particular can be particularly challenging, due to their more vulnerable nature (Greig, Taylor and MacKay, 2007; Tisdall, Davis and Gallagher, 2008).

The key requirements for the current research from an ethical perspective are:

- That there should be informed consent, i.e. that the participants are aware of the nature of the research and are taking part voluntarily
- That the research should not harm or in any other way negatively impact the subjects

In addition, Murphy and Dingwall (2001) suggest that the research should not only not be damaging, but that it should also have positive impact on the subjects involved, rather than being carried out simply for its own sake.

The ethical considerations outlined here were approved by the Graduate School of Education ethical committee, and letters were sent out to parents for consent in August 2009. A certificate of ethical approval is included in Appendix A6.

Informed consent: School A

The Head of School, senior members with a relevant interest (e.g. head of ICT), and the various teachers involved in the project were all involved from an early stage to ensure that the project was in line with the School's goals and would not negatively impact the students learning. Specific lessons and timing for observation were negotiated over a number of weeks prior to the actual research sessions.

Overall informed consent for student involvement was obtained from the students' parents, through a letter sent to them in September 2009. A copy of this letter and the corresponding consent form is included in Appendix A1. In addition all the pupils involved in the research were informed of the intent at the outset of the project and reminded at the beginning of each observation session.

Impact on subjects: School A

The students that formed the sample for the research, and the lessons that were used for observation, were all part of the formal education process, and hence the students should have been developing their knowledge and expertise with French during the observation sessions just as they would have been in their other classes. It was important therefore that the research did not disrupt their learning, hence the content of the lessons was unchanged. The technology provided a new environment for their work, but it did not detour from the curriculum in place at the time.

Informed consent: University of Exeter

All academic and other staff who became involved with the research were fully briefed on the overall purpose of the project. All involvement was entirely on a voluntary basis, and staff were free to cease engagement at any time. Any recordings made were done with the full consent of the individual concerned, and their permission was explicitly sought if any part of the recording was to be made public. The form used to gain this consent can be seen in Appendix E1.

Students who became involved in the research were also briefed on its purpose, though their involvement was not voluntary. As the research meant a permanent change to the teaching and learning methods used in their modules, as approved by their appropriate College accreditation committee in partnership with the lead academic on their module, it would not be appropriate for them to reject the redesigned modules. However it should be noted that the research did not require students to engage with any specific digital technology as a result of the research, technologies were only suggested. Students were free to choose whether or not they used a suggested technology to support their learning. Similar to academic and other stakeholders involved in the research, any recordings made were done with the full consent of the individuals concerned, and their permission was explicitly sought if any part of the recording was to be made public. The same form was used to gain this consent as was used for academics and other stakeholder, and can be seen in Appendix E1.

Impact on subjects: University of Exeter

The research at the University of Exeter was run in collaboration with academic and other staff from the University’s Education Quality and Enhancement unit. This special section of the University has two remits: to enhance existing educational practice, and to ensure that teaching and learning meets agreed quality standards. As such it is staffed by individuals with extensive knowledge of these two areas, who are well versed in the importance of balancing innovative approaches with the teaching needs of staff and the learning needs of students.

The research at Exeter involved a wide spectrum of students at various levels of study, from 1st year undergraduate to master's level. The impact on studies was therefore potentially wide ranging. All interventions at the University were made in accordance with existing guidelines for quality as agreed by Education Quality and Enhancement, and new accreditation was sought from quality review panels where deemed necessary, in order not to negatively impact student learning. With Murphy and Dingwall's (2001) suggestion in mind, that the research should not only not be damaging but that it should also have positive impact, the research was also aligned with existing University strategies aimed at enhancing students employability and digital literacy.

Summary

This chapter has explored the possible methodological approaches, methodologies and methods that might be appropriate to explore a revisited concept of affordances within practical learning scenarios. Using a conceptual framework that combines the basic outlook of ecological psychology with a situated constructivist perspective of learning, it has proposed that an overall post-positivist perspective, together with a design-based research methodology, would be the most appropriate in this circumstance, and it has outlined in some detail the methods and processes that have been set-up to put the research into practice.

The overall goal of the research is to explore whether the theory of affordances can provide the basis for a theoretical framework through which digital technologies can be aligned with pedagogic goals. Using the affordances trinity as outlined in Chapter 3 and Chapter 4, i.e. those of intention, invariant and the 'space of possibilities' of affordance that unites them, this goal has been transformed into three specific research questions that can be empirically explored:

- What role does intention/need play in the detection/use of affordances?
- What invariants within digital technologies make affordances possible?
- What do learners receive from a digital technology, when used in an educational context?

The next chapter documents the initial phase of research that was undertaken to explore these questions, at School A.

Chapter 6: Design Narrative, School A

> *"I never teach my pupils. I only attempt to provide the conditions in which they can learn."*
>
> Albert Einstein, Theoretical Physicist

Introduction

This chapter documents the context, design choices and analysis of research carried out at School A. This exploratory phase of the research studied how the affordances of a specific digital technology were discovered and used by learners in an active learning context. By using an established digital place in repeated learning sessions, the way in which the intention of students shaped the pick-up of affordances through invariants present in both interface and digital place was observed. Using a design narrative approach, issues encountered during research sessions and the evolution of thinking as a result of observations and experiences are presented.

Although planned to run over several terms, a change in personal circumstances meant that data gathering in only one term was possible. Nevertheless, findings from this single iteration, with two cohorts running in parallel, suggest that the formalisation of the affordances trinity; of intention, invariant and the transactional 'space of possibilities' of affordance between them, could provide an initial design framework for further development.

Context

As described in Chapter 5, a three part structure has been used to frame both this chapter and the next. This first part documents the context within which the research was carried out, i.e. the location where the research was carried out, the participants who were involved, and the technologies that were used.

Participants

One of the hallmarks of design-based research is collaboration with practitioners. In design-based research:

> "Practitioners and researchers work together to produce meaningful change in contexts of practice (e.g., classrooms, after-school programs, teacher online communities)."
>
> Design-Based Research Collective (2003, p. 6)

It was therefore necessary to find teachers and learners from the local context willing to participate in a interventionist study that would last several months if not years.
How participants are chosen is a key issue for any research, for a quantitative study in particular, sampling is a key decision (Marvasti, 2004). For qualitative studies such as the present one, however, random sampling from the relevant population is not so crucial, and indeed it may negatively impact the research, and hence it is suggested that a more purposeful approach is taken (Maxwell, 2005; Bryman, 2012). Flick argues that this process of purposeful selection allows you to "select individuals, groups and so on according to their (expected) level of new insights for the developing theory." (Flick, 2006, p. 126).

The current theory being investigated, that of affordances, is a general theory. It is a theory about how individuals make sense of the world around them, how they extract meaning, and as such it neither precludes nor suggests any particular learning scenario. As such it is proposed that *any* learning scenario has the *potential* to provide answers to the research questions set out in Chapter 5. The research questions focus on the relationship individuals develop with digital technologies as learners, they do not presuppose any stage of learning or any specific competence of learners. What the research requires is simply active learners engaged in learning activities, and the opportunity to interject digital technologies into these learning activities and study the resulting interactions.

I used personal contacts to explore research opportunities with several teaching professionals, and teachers at a local secondary school, School A, responded positively to the idea. Due to my existing connections with the School there were fewer barriers to setting-up research, and conversations with the Head of ICT and the Head of Modern Foreign Languages were arranged and took place late in 2008 to discuss potential options, with a view to starting the research in school in September 2009. Modern Foreign Languages (MFL) was considered as having good potential for exploring digital technologies in teaching and learning, due to their use of not only written texts but also spoken text. The ability of digital technologies to work with multiple forms of media is often highlighted as one of its strengths (e.g. Conole and Dyke, 2004), and therefore it seemed wise to make initial research options as broad as possible.

The following needs were identified from the research perspective:

- Software with the capacity to provide numerous potential affordances would need to be installed on classroom computers
- Use of this software would be required as part of the normal teaching practice in lessons, together with the opportunity for reflection after use
- Observation of students using the computers in their learning in real time

When carrying out design-based research, it is important that local needs are considered and integrated into the overall research design. The needs and goals of the research must work in harmony with the needs and goals of the practitioners, otherwise there exists a high risk that the research will fail due to mismatch with the motivations and goals of those involved:

> "Goals and design constraints are drawn from the local context as well as the researcher's agenda."
>
> (Design-Based Research Collective, 2003, p. 6)

Negotiations took place to discuss how much time would be realistic from the School's perspective, and considering the needs of the research outlined above, two classes were identified from the MFL department which seemed suitable, meeting the needs of both the research, the practitioners and the students. The two classes were both studying French at key stage 3 and 4, so pupils tended to be between 13 and 15 years old, and both classes were co-educational:

- The first class was known internally as 10C/FR1 (year 10, French class 1), taught by Teacher A, and consisted of 22 pupils. These classes took place at 9:00 on a Wednesday morning.
- The second class was known internally as 9X/FR1 (year 9, French class 1), taught by Teacher B, and consisted of 32 pupils. These classes took place at 14:15 on a Wednesday afternoon.

Students were following the national curriculum in French, modern foreign languages programme of study. Their key text book was "Metro" (McLachlan, 2001).

Design-based research focuses on working with practitioners in general, not simply teachers or educators. As such it was important in involve all those stakeholders who could have an impact on the learning scenario, and when using digital technologies to support learning this invariably includes learning technologists or their local equivalent. Learning technologists are arguably a key part of any successful technological intervention in learning, and should not be left out of the research design (Salmon, 2013). A full-time technical support member of staff was therefore included in the design process, to ensure that the necessary software and hardware were properly configured and available.

Finally there were various teaching assistants present at different lessons, though these were almost entirely dedicated to specific pupils, and therefore had limited impact on the overall learning process.

Real environment

The real environment that the research took place in were the standard classrooms within the school premises that the pupils were used to studying in, as shown in Figure 6.1. Their standard school issue laptops were also used (mostly Dell Latitude D510, with a few Dell Latitude D505), and the additional software was installed individually on each machine ahead of the research.

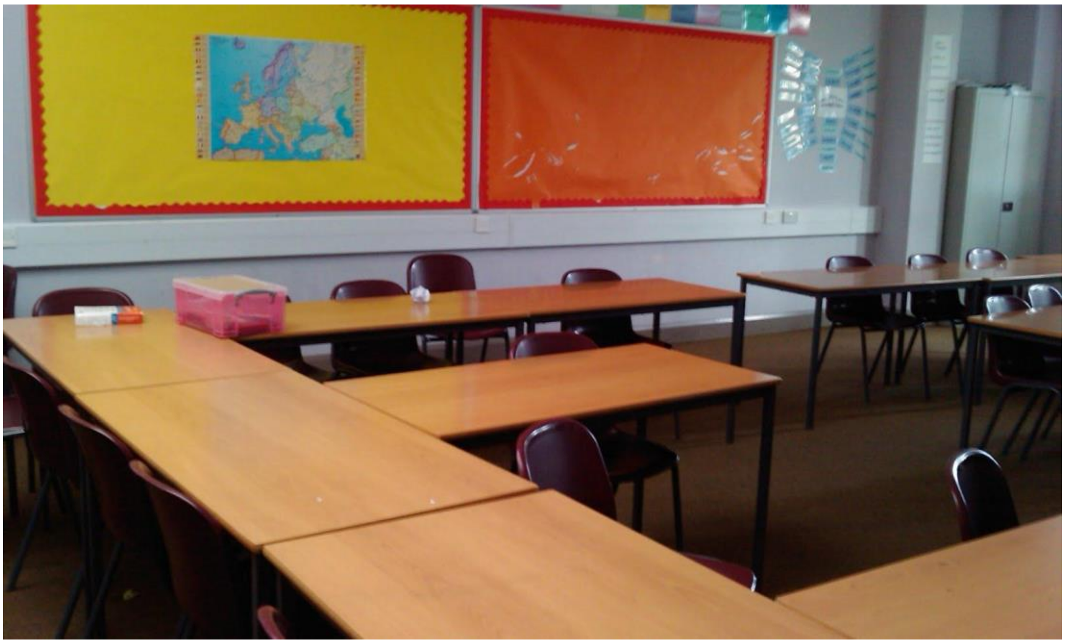


Figure 6.1: Modern Foreign Language (MFL) classroom at School A

In addition 15 simple webcams were purchased with built in microphones (Logitech QuickCam E3500), and these were distributed to each student team during each session when the research was taking place, and then collected again after the session had finished.

Digital environment

Chapter 4 has outlined a way of thinking about digital technologies that considers them not simply as tools, but also as digital spaces and digital places in their own right. Digital places may contain tools, but it has been argued that they are not synonymous with tools, and that by treating them as broader *places* the affordances they might provide for learning might be better identified and better understood.

The rationale of the research is that given a sufficiently rich and flexible digital place to study, specific invariant/affordance combinations should be discoverable - and useable - by learners, and observable by researchers. The question now turns to this notion of a sufficiently rich and flexible digital place within which to study. The terms rich and flexible are defined, and the important role of the interface is clarified.

A 'rich' place

Although it has been argued that all digital technologies have the *potential* to create digital space and consequent digital places, the 'richness' of these places does necessarily differ from technology to technology. A rich technology is defined as one which supports the ability to use multiple forms of representation, e.g. text, video, audio, imagery, etc. how well the digital place can handle multiple forms of media and representation, how well it can simulate the real world and represent conceptions of it back to the user.

There is a tendency in technological research to discuss digital technologies in general terms (e.g. Laurillard, 2012), and as interchangeable types such as Wikis, Blogs, etc. In practice, however, this generalisation can obscure the wide variance that exists in the online world:

> "The exceedingly wide range of different online learning experiences ... attest to the fact that 'online learning' is too broad a category to label as effective or ineffective."
>
> Means (2014, p. 178)

Invariably different instances of types of technology can offer a vastly different 'richness' of place. To take an example, one type of mobile telephone may provide the ability to support only audio, with limited text input, limited single line monochrome display, and the audio generated may be transient only, i.e. have no capacity for storage and replay. A similar mobile telephone may also only allow audio, but may have a complex multi-colour, multi line display, and allow for the storage and replay of conversations. Although these are both phones, the richness of the digital places they create are significantly different, so it is argued that they should not be considered as equals. Even amongst types of technology that are generally considered as a single type, e.g. smartphones, the variation can be vast within this group. The difference between a top of the range iPhone and a budget device, for example, can be as wide as that between a smartphone and a feature phone.

From the perspective of the current research, a rich place should support diversity in both the types and the number of affordances and invariants available to be discovered.

A 'flexible' place

Another requirement for the digital environment is that it should be flexible, i.e. that there should be some opportunity for users of the space to be able to move and reshape the digital objects within it, to be able to reform the place according to their needs. This is tied directly to the concepts of constructivism, as Chapter 4 has discussed learners should be active participants in the learning process, as knowledge and understanding is developed through active construction and experience and not through passive consumption (Dewey, 1916). Too often digital environments are rigid, inflexible places that deny students the ability to create and produce (Selwyn, 2007).

A flexible technology is defined as one which supports 'interpretive flexibility' (Pinch and Bijker, 1984), i.e. the ability to be used in complex ways based on the needs of the individual, as opposed to constraining or limiting the student due to its design (Doherty, Coombs and Loan-Clarke, 2000).

From the perspective of the current research, a flexible place should enhance the ability of the students to discover invariants and related affordances, both as independent learners and through other learners.

A 'usable' place

A key requirement for digital technologies in general is usability, i.e. that the methods by which a user can perceive, move within and change a digital place should be as intuitive as possible. By utilising metaphors, either with existing digital technologies or with the real world, the system should be as usable as possible. Metaphors are useful because they:

> "… facilitate easy learning as they allow users to draw upon their pre-existing knowledge of familiar domains when attempting to get to grips with new ones"
>
> (Etre Newsletter, July 2008)

Usability was considered especially important in the research as there is an inherent danger in studying the use of a digital technology that the study starts to reflect on the nature of the digital technology itself, rather than on the use by teachers and learners. This can mean that results about the quality of the interface are blended in with results about the learning processes that are taking place, therefore making results of the study difficult to interpret and generalise upon. As experienced by previous researchers, e.g. Laurillard (2000) in their work exploring the design features of multimedia CD-ROMs that might afford activities that generate learning, if a particular interface is not well designed then there is a danger the research will become bogged down in operational activity unrelated to the learning that the teacher - or for that matter the student - intended:

> “The focus of their attention is all on the task form, and the navigational aspects of the interface.”
>
> Laurillard (2000, p. 7)

With complex and unintuitive interfaces students can become embroiled in learning the interface to the software itself, rather than any learning objectives as set by the teacher. By selecting software with an inherently usable interface, more time can be spent using the software for learning, as opposed to learning how to use the software. It should also make the process of distinguishing between invariants in the interface and invariants in the place that much simpler.

Given the three requirements as outlined, that the digital place should be rich, flexible and usable, a specific digital technology was chosen to support learners within the research. This technology was Adobe Visual Communicator.

Adobe Visual Communicator

Adobe Visual Communicator is software owned by the Adobe Corporation in the United States of America. It is a unique piece of software, with no equivalent from other providers, which allows users to create newscast quality video presentations using a simple drag and drop interface. I became aware of this software through a professional relationship with Adobe, that of an "Adobe Education Leader". The Adobe Education Leader programme "highlights the contributions of innovative educators in K–12 and higher education who are effectively using Adobe tools and applications to promote excellence in the classroom". The programme is designed to cultivate education technology innovations by providing educators with resources such as education software, free curriculum, training, and a forum to share best practices.

Figure 6.2: Adobe Visual Communicator software packaging

Adobe Visual Communicator was originally developed by the company "Serious Magic", and early in its development the possibility of use in teaching languages was considered by the development team (personal conversation with developer). In 2006 it was purchased by Adobe and it was added to their extensive suite of software, and it has been widely used in education (personal conversation with Adobe staff, Adobe Education Leaders) though primarily for news broadcast. A fellow Adobe Education Leader, Rob Zdrojewski, has made extensive use of the software in his K-12 teaching in the USA[1].

Although the software is expensive, retailing for a little under £400 a copy, through my links with Adobe as an Adobe Education Leader it was possible to acquire multiple copies of this software for free for use in educational research. It should be noted from an ethical perspective that there was no attempt by Adobe to push this software into Schools, the company provided me with the opportunity to have any one of their products for free through my role as an Adobe Education Leader. 15 copies of the software were therefore obtained and arrangements were made with the school to have them installed on the laptops that were used by the two classes.

[1] http://en.wikipedia.org/wiki/Adobe_Visual_Communicator

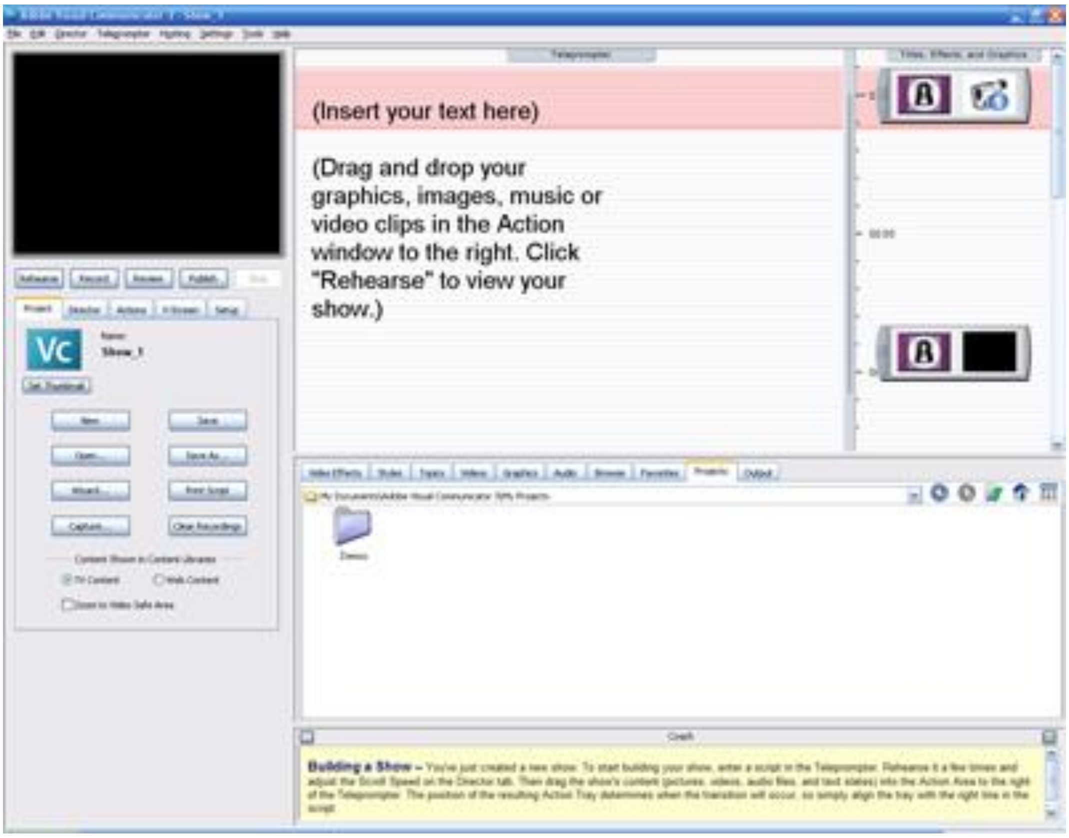


Figure 6.3: Adobe Visual Communicator main interface

The core of the digital place that the technology provides is a timeline, shown in the top two windows of the screenshot in Figure 6.3. This timeline can be moved up and down as content is inserted, and this can be done either manually or automatically. The speed at which the timeline moves can also be controlled. Text content can be freely created in the left hand side of this window, whereas the window on the right of this timeline allows the insertion of other media forms and shows which media objects will be activated and when this will take place. It will show, for example, when the camera will switch on or off, images will appear, or text slides/subtitles will be shown. The bottom panel displays objects which may be inserted into the timeline, either from pre-existing libraries or from personally created places. The left hand panel controls the overall mechanics of the place, i.e. which particular camera is chosen or how fast the timelines moves. Finally the top left window displays the image from the camera, and has controls to start, stop and record the timeline itself.

The digital technology fulfils the requirement for richness due to its ability to combine multiple media formats in the same place. Not only text but also pictures, audio and video can be combined into the digital place created by the technology. The technology is unusual in that it allows for audio and video to be introduced directly into the digital place as easily as adding text or imagery.

Whilst not completely flexible in terms of creation, for example the timeline constrains creation along a linear path, the technology does offer a very broad ability to add different forms of content and change its overall combination. It does not attempt to lock content into specific placeholders, but allows for a free form approach. It is also flexible in that most of the functionality can be manipulated by the learners.

Whilst there are few if any independent metrics which can be used to measure the usability of a digital technology, usability itself can be split into 5 different components (Nielsen, 1994):

- *Learnability*: The system should be easy to learn so that the user can rapidly start getting some work done with the system.
- *Efficiency*: The system should be efficient to use, so that once the user has learned the system, a high level of productivity is possible.
- *Memorability*: The system should be easy to remember, so that the casual user is able to return to the system after some period of not having used it, without having to learn everything all over again.
- *Errors*: The system should have a low error rate, so that users make few errors during the use of the system, and so that if they do make errors they can easily recover from them. Further, catastrophic errors must not occur.
- *Satisfaction*: The system should be pleasant to use, so that users are subjectively satisfied when using it; they like it.

Nielsen (1994, p.26)

Usability analysis is often carried out by an expert using heuristic analysis, often with guidance such as this to measure against. I have a master's level qualification in "User Interface Design and Evaluation", hence could be considered an expert myself, and using this guidance my personal evaluation of the software found it suitable. However, there were some concerns over software stability, and these are discussed in more detail in both the implementation and the analysis sections, below.

Intervention design and implementation

As described in Chapter 5, the initial design for the first iteration at School A was relatively straightforward - take an existing learning scenario and swap the real world environment for a digital environment. Instead of using their desks, paper, pencils etc. to support their studies, in the lessons under observation these real places would be swapped for digital places within which to create and discuss. Instead of creating marks on paper, students would be creating text within Adobe Visual Communicator, instead of simply uttering French into the real place, their speech would also be recorded and stored in the digital software. The learners' use of this digital place over an extended period of time would be studied in relation to the three research questions, and changes to the way in which the place was used would be introduced over time in response to analysis of the data gathered.

Students' normal working practice was to work in small groups of 2-3, focusing on a specific topic for half of each term, and developing their understanding of French through four attainment targets as set out in the National Curriculum (2007):

- Listening and responding
- Speaking
- Reading and responding

- Writing

The digital place provided by Adobe Visual Communicator software was able to support all four of these aspects of language learning, through its ability to record and playback audio and simultaneously align a written script with this recording.

The research sessions began in the 2009/2010 academic year, starting in the Autumn/Winter term. Class 10C/FR1 were studying “health/unhealthy living” for the first half of this term, followed by “relationships” after the half term. Class 9X/FR1 were studying “school” for the first half of the term, also followed by the topic “relationships” after the half term.

The overall goal of the study was to explore how affordances might be used to align pedagogy and technology. As Chapter 3 has discussed, the theoretical position of the research proposes that many potential affordances should be present in interactions between learners and digital technologies, but that these affordances and interactions probably occur in a semi-random, ‘interpretive’ way that is not intentionally designed into learning scenarios. The purpose of the initial phase of research was to apply rigorous research methods to this digitally rich learning scenario in order to try and tease out these affordances, and the corresponding roles of intention and invariants. This approach, that of studying a specific instance in order to “illustrate a more general principle” is most commonly referred to as a case study approach (Nisbet and Watt, 1984). The overall design-based research approach therefore begins with a case study, which aims to outline an initial framework within which the components of affordances are identified.

Yin (2003) identifies three different types of case study: Exploratory, Descriptive and Explanatory. It was decided that an exploratory case study would be the best overarching method within which to investigate the digital place and look for affordances as it "investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (Yin, 2003, p. 23). This initial case study acts as a first ‘foundation stone’ from which further iterations are planned under the wider design-based research methodology.

The main strengths of the case study approach include in its ability to capture unique features, to provide insights into similar situations, and to be manageable by a single researcher (Cohen et al, 2000). These three strengths in particular make the approach well suited to the research being undertaken. The main weakness of the case study approach is that results may not be generalizable, a weakness that has also been levelled against design-based research:

> “It is also the responsibility of the design-based researcher to remember that claims are based on researcher influenced contexts and, as such, may not be generalizable to other contexts of implementation where the researcher does not so directly influence the context.”
>
> Barab and Squire (2004, p. 11)

Edelson (2002) proposes that this may be mitigated by limiting what is claimed through design-based research, framing three ‘products’ which he calls a domain theory, a design framework and a design methodology. Each of these becomes less focused on the specific implementation in question. This concept will be returned to later, but it is important perhaps to clarify here that although initial results from the research might be only applicable in context, approaches exists to broaden and extend results beyond the current implementation. This initial plan is intentionally quite loose and unstructured, in order to develop theories and further iterations from data gathered, as recommended by Wang and Hannafin (2005, p. 8).

Yin (2003) identifies six primary sources of evidence for case study research:

- documentation
- archival records
- interviews
- direct observation
- participant observation
- physical artefacts

Table 6.1, below, lists the strengths and weaknesses of each type of evidence.

Source of Evidence	**Strengths**	**Weaknesses**
Documentation	• stable - repeated review • unobtrusive - exist prior to case study • exact - names etc. • broad coverage - extended time span	• retrievability - difficult • biased selectivity • reporting bias - reflects author bias • access - may be blocked
Archival Records	• Same as above • precise and quantitative	• Same as above • privacy might inhibit access
Interviews	• targeted - focuses on case study topic • insightful - provides perceived causal inferences	• bias due to poor questions • response bias • incomplete recollection • reflexivity - interviewee expresses what interviewer wants to hear
Direct Observation	• reality - covers events in real time • contextual - covers event context	• time-consuming • selectivity - might miss facts • reflexivity - observer's presence might cause change • cost - observers need time
Participant Observation	• Same as above • insightful into interpersonal behaviour	• Same as above • bias due to investigator's actions
Physical Artefacts	• insightful into cultural features • insightful into technical operations	• selectivity • availability

Table 6.1: Strengths and weakness of sources of evidence, Yin (2003, p. 80)

With these in mind, it is perhaps worth reiterating the main research questions as outlined in Chapter 5 that are being investigated, and to compare these with the sources of evidence proposed. These three research questions are:

- What role does intention/need play in the detection/use of affordances?
- What invariants within digital technologies make affordances possible?
- What do learners receive from a digital technology, when used in an educational context?

Of the sources of evidence listed in Table 6.1, the last three are arguably of most relevance and interest to the current research. The created (digital) artefacts will help to understand how invariants in the digital place are perceived and utilised. Direct observation / participant observation should allow the researcher to follow a process as it unravels in real time, how intention leads to the discovery of invariants and subsequent utilisation of an affordance that is at the heart of the current research. As such these observations should provide the main source of evidence for the research. Observation should also reveal what learners receive back from a digital technology, through the conversations that spontaneously arise between students and the actions that they carry out.

Preparatory work

Technical problems can be a major barrier to teachers and students, preventing them from using digital technologies effectively in the classroom (Bingimlas, 2009). It is therefore important to take all steps to ensure that any technological innovation in the classroom is as trouble free as possible. In the context of the present research, successful research observation sessions will only be possible if the digital environment that is used is stable and can perform at an acceptable level of performance.

Some preparatory work was carried out to ensure that the software was successfully installed on the School laptops that were being used for the research, and that it was functioning correctly. Meetings were arranged with technical staff from the School on several occasions, in order to qualify what was required from a technical perspective, and what would be possible given the constraints that the School had to work within, such as network bandwidth, internet blocking, wireless access, etc. Various practice sessions were carried out with the technology ahead of the actual research sessions, and the technology performed well for all of these requirements.

Trial sessions were also ran in the classrooms planned for the research sessions in the Spring term prior to the research itself, mimicking the exact conditions under which the observation sessions would occur, to ensure that all possible precautions and eventualities had been planned for. Specifically, tests were carried out for:

- Installation and performance of core Adobe Visual Communicator software (main program)
- Installation and performance of additional Adobe Visual Communicator software (additional images, graphics, transitions, etc.)
- Installation and performance of student webcams
- Position of observation video camera, to ensure clarity of image and audio
- Stability of data files, in terms of network and local storage
- Wireless network performance

Figure 6.4: Author exploring options in the observation classroom during the preparatory work

Research instruments

A research instrument can be defined as “any technique or tool that a researcher uses, e.g. a questionnaire, an interview schedule, observational framework, etc.” (Hammond and Wellington, 2013, p. 169). In order to produce data than will meet the objective of answering the research questions, a combination of qualitative and quantitative research instruments were either designed or chosen. This type of mixed methods approach is wholly consistent with a design-based research approach, and has been identified as one of its key hallmarks (Anderson and Shattuck, 2012).

Qualitative and quantitative research tend to differ in their overall objectives, as Punch summarises, “quantitative research has typically been more directed at theory verification, while qualitative research has typically been more concerned with theory generation” (Punch, 2005, p.16). Tashakkori and Teddlie (2002) agree that whilst quantitative and qualitative research methods do not exclusively match either a theory generation or theory confirmation position, nevertheless qualitative research is better suited overall to exploratory questions.

The research questions as posed could arguably be characterised as research verification, as they are attempting to better understand the theory of affordances. A case has been made, however, that what is missing from research into educational technology is a theory of technology itself (Oliver, 2012), and that the theory of affordances might be able to help underpin this. It has also been argued that the theory of affordances as it is currently understood has been distorted by multiple interpretations, and was written for a non-digital world. The aim of the current research is therefore to *generate* theory to enhance that which currently exists, not to confirm existing theory. As such, a focus on more qualitative forms of research is most appropriate.

The qualitative approach therefore forms the heart of the research, the quantitative methods being primarily in place to maintain a baseline of data to monitor the progress of the research, and to triangulate any issues as and when they might arise. Whilst not strictly verification tools in terms of verifying theory generation Punch (2005), they are being used in a verification context in order to monitor the progress of the first research phase.

Qualitative research instrument: Classroom observation

The heart of the research comprised 14 lesson observations of the two classes selected. These took place from September 2009 to December 2009 every Wednesday (barring school breaks), with one class (10C/FR1) first thing in the morning and another class (9X/FR1) last thing in the afternoon. Students were briefed about the specific focus of the lesson for approximately 5 minutes, and then worked in small self-selected teams of between 2-4 individuals each, with one laptop between them, for the majority of the lesson. Each laptop was issued one webcam.

In each case the task was very similar, the students were asked to create within the software a narrative in French of a conversation between themselves regarding some recent real activity or fictional activity. They were supported in this through their standard textbooks, i.e. the task itself was drawn from their standard curriculum material, and was not chosen specifically to suit the technology. The intention was at all times to preserve the standard teaching methods and processes that both the students and teachers were used to, but to introduce the technology as an additional digital place for creation and collaboration between the students, alongside the existing real space. The students had an upcoming assessment later in the year, a ‘controlled task’ where they would be assessed on their ability to speak in French and hold a conversation, and these sessions were practice for that later event.

Approximately 5-10 minutes into the teaching session a group of students was chosen to be observed, the choice based on the apparent engagement of the students with the activity. As previously argued, the key requirement from a sampling perspective was that useful data could be gathered, so groups who were actively engaged in learning and appeared to have no difficulties were chosen for preference. Each group was first asked if they were happy to be observed for the purposes of the research.

According to Vreede (1995), the role of the researcher in a case study is simply as observer. The purpose of the case study is to explore or explain a real life event, in this case the role of digital technology within a learning scenario, and as such it is important to remove as far as possible the potential impact of the researcher on the events that are being explored in order to maintain as true a picture of events as possible. The unit of analysis (Trochim, 2006) in this research, however, are the affordances that are provided or furnished by the digital place that is being used by the students. These affordances are a product of the invariants experienced within the digital place, and the intention of the student learners, and as such a rich picture of both of these needs to be captured simultaneously if emergent affordances are to be observed and discovered. This provides something of a quandary: How to study this rich interaction in such a limited interaction space (i.e. that between the students and the technology) without impacting the event itself.

The advent of small, powerful video cameras with long battery life offers a discreet and rich method to achieve the desired result. These types of camera have reached a level of development where very high quality capability can be packaged into a very small form factor at relatively inexpensive costs, and as such can provide an acceptable ‘proxy’ for the researcher. By placing the camera in very close proximity to the students, using it to watch their interactions with the technology whilst simultaneously recording their interactions together, a rich picture of the intention, invariants and resulting affordances of the digital place as experienced can be gathered with very small researcher impact on the learning scenario. Figure 6.5 shows the typical perspective of these cameras within the research sessions.

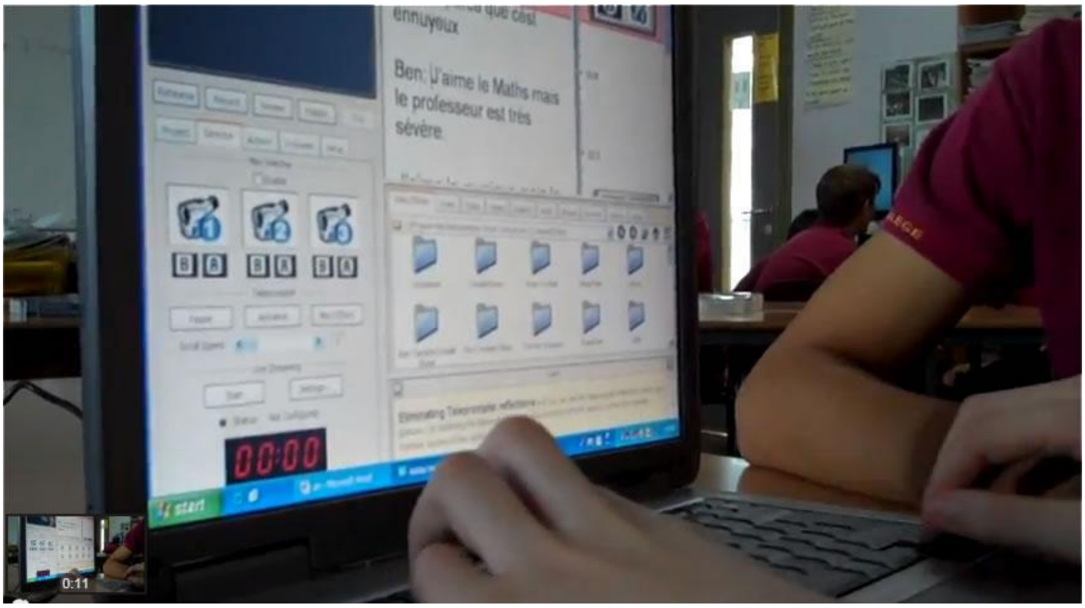


Figure 6.5: Typical perspective as seen from the camera during classroom observation

The particular camera chosen for the research was a Flip Ultra HD, which was capable of operating for 2 hours and storing 2Gb of data, and could capture video data at a high definition resolution of 720p together with audio from a built in microphone. This was partnered with a Gorillapod tripod, which are capable of being attached to almost any object, which gave me flexibility in the local situation. The camera could be attached to a table, to a chair, to a laptop; almost any object could be a suitable mounting point.

Figure 6.6: Flip Ultra HD video camera

Figure 6.7: Gorillapod flexible tripod

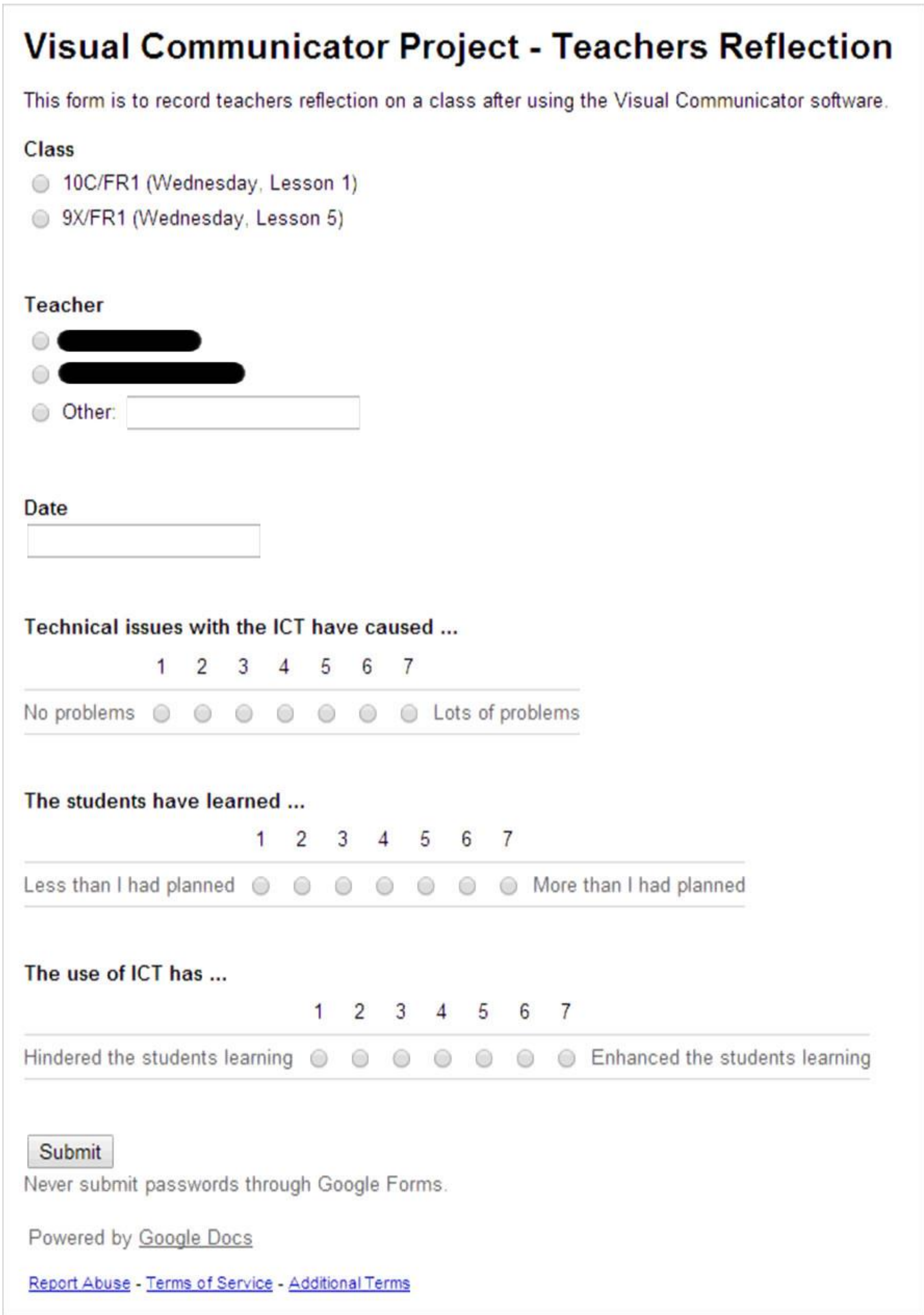
Quantitative research instrument: Participant evaluation ratings

Conventional educational research based on an experimental model often attempts to control variability within the research, in order to identify the effect of a limited number of specific variables. Design-based research, in contrast, works in real world settings where this is very difficult, and hence it generally tries to identify the role of any variables that appear to have an effect on the variables of interest (Collins et al, 2004). In the present context the variables of interest are the interactions between individual learners and the digital places created by the technology. Other variables that might impact this process are the teachers involved and their individual styles of teaching, the dynamic between individual learners on any particular day, and perhaps most importantly the level of performance of the technology.

In order to gather a baseline of data for these types of variables, which could then be compared with data collected through the video camera, two methods were developed for evaluating the experiences of participants. The rationale for this was straightforward: by gathering data that could be analysed quantitatively from both teachers and pupils, this would allow a degree of comparison later between research instruments, which might help in explaining and/or corroborating anomalies in the data, providing a form of triangulation. Conscious of time pressures in the class environment, these methods were designed to be especially simple and quick forms of gathering data, one for teachers and one for pupils.

The teacher evaluations consisted of three short questions, with responses on a Likert type scale of 1 to 7. The three questions were presented on an A4 sheet at the end of the class, and the teachers were asked to reflect on how the session had proceeded in relation to the three questions. They were left to complete this by themselves to reduce any potential researcher bias. A scale of 5 was initially chosen, but this was increased to 7 after the first two sessions in order to increase the sensitivity of the instrument. According to Carifio and Perla (2007) this should also improve the linearity of the scale, hence improving its reliability when performing any quantitative analysis using the data.

An image of this A4 sheet in presented in Figure 6.8, below. As can be seen from the image, Google Docs was used to create the form, even though paper copies were used in practice. Paper was deemed more suitable for a noisy, busy classroom environment, especially during the closing stages of a lesson. The digital version of the form was used later to enter the data electronically, in order to move it into a form where it could more easily be stored, secured and ultimately analysed.



Visual Communicator Project - Teachers Reflection

This form is to record teachers reflection on a class after using the Visual Communicator software.

Class

- 10C/FR1 (Wednesday, Lesson 1)
- 9X/FR1 (Wednesday, Lesson 5)

Teacher

- [redacted]
- Other:

Date

Technical issues with the ICT have caused ...

	1	2	3	4	5	6	7	
No problems								Lots of problems

The students have learned ...

	1	2	3	4	5	6	7	
Less than I had planned								More than I had planned

The use of ICT has ...

	1	2	3	4	5	6	7	
Hindered the students learning								Enhanced the students learning

Submit

Never submit passwords through Google Forms.

Powered by Google Docs

Report Abuse - Terms of Service - Additional Terms

Figure 6.8: Teacher reflection questionnaire

The purpose of these questions was not to answer research questions directly, but to provide baseline evidence of the impact of the digital technology on learning.

The first question was designed to monitor the performance of the technology across the sessions. The world ICT was used in place of digital technology as this was the language used to describe digital technologies within the English school system at the time; it was the language of the “Community of Practice” (Lave and Wenger, 1991) in question. As has already been discussed, technical failure in educational technology research is far from uncommon, and can be a significant problem when trying to understand results. The first question was designed to monitor this effect, together with notes taken throughout the observation sessions, as a means of identifying negative impacts of the technology on the learning process.

The second question was designed to monitor the teachers overall and immediate reflection on how well the students were learning during the session. The answer to this question would then be compared with the answers from the other questions, research notes taken during the session, and data from the videos, in order to corroborate or explain unusual or unexpected results.

The third question was designed to try and tease out the effect on learning of the technology from the overall learning that may have taken place, but was purely a subjective interpretation from the teacher. Again its purpose was in helping to corroborate or explain issues uncovered later in analysis, and not as a direct measure of student learning in order to show causal links or otherwise ‘prove’ the effect of technology on learning.

The spreadsheet summary of data gathered during all the sessions is included in Appendix A2, and also summarised in this chapter in table 6.3 (p. 196).

In parallel with the thoughts of the teachers about the overall learning experience, a separate research instrument was devised to monitor the students’ perceptions of how much they had learned during the sessions - student ‘star’ cards. As before, the purpose of this instrument was to provide a subjective quantitative measure that could be compared at a later date with other data in order to explain and/or corroborate any anomalies. Again, the instrument was designed so that it could be used quickly and efficiently in a busy teaching and learning environment.

These star cards were approximately the same size as a business card, but printed on ordinary paper. These contained the short question "How much have I learned today?" and underneath were printed five empty stars, which students were encouraged to mark in such a way with a pencil, pen or similar in order to indicate how much they thought they had learned during the session. An example of one of these cards is shown in Figure 6.9.

Figure 6.9: Blank student star card

The cards were issued to the students at the end of each teaching session, and collected back as soon as they had been completed. A visual summary of the data gathered using these star cards is presented in Figure 6.11 (p. 199) and the spreadsheet summary of all data gathered during the sessions is included in Appendix A3. In order to ensure accuracy of data entry, the number of star cards was automatically calculated using this spreadsheet, and then actual number of physical cards was counted manually. This helped to ensure that all data was entered into the spreadsheet.

Alongside these methods for evaluating participant experiences, a template for “research notes” was designed ahead of these classroom observations, in order to organise the information about each session and allow for observational notes to be taken in an organised fashion during each observation session. This template included placeholders for:

- Class (including time and date)
- Teacher
- Technical issue score
- Students learning score
- Use of ICT score
- Number of pupils
- Total ‘Star’ Score
- Objective of lesson
- Equipment being used
- General notes on session

My personal preference is to use a pen equipped tablet computer for note taking, specifically a Motion Computing LE1600 (shown in Figure 6.10), and the templates were designed for use with this technology using the Microsoft OneNote software. This software can be used for working in both print and digital, so paper copies have also been produced. A blank example of these research notes is therefore included in Appendix A4, and the full set of research notes is included in Appendix A5.

Figure 6.10: Motion Computing LE1600 tablet computer

Data analysis

The research instruments designed to gather data during sessions with the participants, and the manner in which they will be used, has been described in full. An outline is now provided concerning the manner in which the data from these research instruments was analysed.

At the heart of qualitative research lies the interpretation of data, and the most common method for achieving this rigorously and reliably is through coding. Coding is a way of highlighting the salience of specific observed data sections, using succinct terms which are relative to the broader context of the research questions being explored. Strauss highlights the central criticality of coding to the qualitative researcher:

> "Any researcher who wishes to become proficient at doing qualitative analysis must learn to code well and easily. The excellence of the research rests in large part on the excellence of the coding."
>
> Strauss (1987, p. 27)

Grounded Theory, originally developed by Glaser and Strauss in The Discovery of Grounded Theory (Glaser and Strauss, 2009), was conceived specifically to try and generate theory directly from the data using a rigorous approach to coding, and is one potential method that could be applied within the current research. It is an inductive or grounds-up approach (Marvasti, 2004) that 'grounds' any theory developed in the data that it originates from. The key characteristics of coding from a grounded theory perspective can be summarised as:

- Look for salient categories, label phenomena
- Avoid mere description
- Use a constant comparative approach
- Saturate (i.e. code and recode until it is not possible to code anymore)

Theory is developed through writing memos, short descriptive prices that summarise how codes relate back to the data and to each other, whilst constantly comparing and contrasting the codes that emerge from the data.

Grounded theory is a robust and comprehensive approach to qualitative analysis, which uses a formal set of steps in order to build a rigorous analysis of data sets. It is, perhaps, even too rigorous in the present context. The amount of data gathered during the research was extensive, in the sense that it took place over an extended period of time, but at the same time it covered only a limited number of cases, hence the amount of analysable data was relatively small.

Thematic analysis is another approach that has the potential to be applied in the present context. Whether thematic analysis is a specific approach in its own right, or simply a method that many different types of qualitative research might use, is debateable. Ryan and Bernard (2000) suggest that it is simply a process which is performed within more major 'analytic traditions', such as Grounded Theory. Others argue that it should be considered in its own right (Braun and Clarke, 2006).

Bryman (2012) observes that thematic analysis is widely used, but appears to have little identifiable heritage. They suggest that because it does not have a ‘branded’ name, as do other approaches such as Narrative Analysis or the aforementioned Grounded Theory, it has not received the widespread documentation of other data analysis methods. Nonetheless, Bryman comments that it appears to be not only a very common approach, but one that is being used more frequently. In searches online they noted their 2000-2007 figure of 400 publications referencing the approach had risen to 1,184 across the 2000-2010 time period, a large increase (Bryman, 2012, p. 579)

Braun and Clarke (2006) propose that thematic analysis is a foundational method for qualitative analysis. They argue that it’s flexibility and accessibility makes it an ideal method for general qualitative research, and in particular for those new to the field, as it helps to develop core skills in qualitative analysis that will be applicable within many different methods and approaches. From that perspective, it is potentially well suited for the current context.

The notion of what exactly a theme is debatable (Bryman, 2012), but four points have been proposed which should help to clarify and distinguish them during data analysis:

- a category identified by the analyst through his/her data;
- that relates to his/her research focus (and quite possibly the research questions);
- that builds on codes identified in transcripts and/or field notes;
- and that provides the researcher with the basis for a theoretical understanding of his or her data that can make a theoretical contribution to the literature relating to the research focus

Bryman (2012, p. 580)

Themes are can be drawn out using an inductive approach, i.e. by letting the data suggest themes in a approach similar to that used in Grounded Theory, or in a deductive approach, using the research questions and overall goals of the research to focus analysis on emerging themes that match the focus of the research (Boyatzis, 1998). In practice, thematic analysis tends to take place somewhere along the continuum formed by the two ‘ends’ marked by induction and deduction. In the present context, more of a deductive approach has been taken, attempting to align themes with research questions as suggested by Bryman (2012).

Use of CAQDAS (Computer Aided Qualitative Data Analysis Software)

When using video or audio data, transcripts of these are often made and then these transcripts are then coded rather than the primary data sources. For video in particular, a common first step before analysis might be to transcribe the talk that takes place against a timeline, and then annotate the timeline with additional columns of data that describe events that are happening on the screen. I had concerns about this method of data summarisation, that reducing the interactions to written summaries which were then coded in turn would narrow the breadth of potential interpretation. Methods were sought which might allow coding of the video directly, rather than coding an interpretation of data.

Markle, West and Rich (2011) suggest that methods are always adapting and evolving, and that advances in technology have often led to advances in methods, as new capabilities of technologies are applied to existing research problems. Taking audio interviews in the field, for example, for later analysis. Although they appreciate that transcription has a long and proven history, they argue that its continued use with rich media forms, such as those being used in the present research, can be inappropriate.

> “The professed benefit of using recorded audio and video is increased

> authenticity. Yet transcribing spoken data inevitably loses information as the concrete event or emotional response is translated into written language - a symbolic form inherently less rich and authentic. Thus transcription can result in the loss of pragmatics - the role of context and inflection on speech. For example, the simple greeting "Hello" may be said in any number of ways that change the speaker's tone and intent. Turning audio data into text data sacrifices elements of natural speech such as intonation, pause, juncture, pitch, stress, and register that convey added information by helping to place spoken words inside a greater contextual reference that increases insights and understanding beyond the words."
>
> Markle, West and Rich (2011)

The key to the current research is in understanding the relationship between the intention of individual learners, invariants within the digital place that they are interacting with, and the affordances that emerge between these two. As has been argued earlier, affordance is a relational concept, and that relationship is defined between individuals and the invariants in the world around them, whether that world is real or digital. In the present context, the risk is that transcription would remove data concerning this interaction above and beyond emotional response such as intonation. Many other types of interaction were observed during the research sessions, e.g. gesture between subjects, movement of laptops and other peripherals, adjustment of participants, etc., the richness of which would be lost through transcription into text.

Creswell (2009) suggests that using CAQDAS programs to code and understand data directly has multiple benefits over transcription, including rapidly locating all instances of use of a single code, identifying and visualising links between different codes across different sources of data, and combining multiple media types of data. They suggest four different CAQDAS software packages, MAXqda, Atlas.ti, QSR NVivo and HyperRESEARCH. Reviewing the appropriateness of these four software packages in the present context suggested that QSR NVivo would be most appropriate, due to its advanced ability to manage and analyse video data. It supported the type of direct coding required by the research, as it allowed codes to be embedded directly into the video stream as opposed to transcribing the video and then coding the resultant script. As Hammond and Wellington (2013, p. 23) note, coding directly in this way has the advantage of linking directly to the data, but does take more time than analysing a written transcription. The Nvivo software does, however, allow time to be speeded up during analysis, and interesting affordance in itself which it will be seen has parallels with the emerging analysis.

Outcomes and analysis

This section forms the main narrative describing the outcomes and analysis of data gathered during work with School A.

Braun and Clarke (2006) define three terms that help to clarify what type of data is being referred to, data corpus, data sets and data item. The term ‘data corpus’ is used when referring to all the data that has been collated during a research project. The term ‘data sets’ is used when referring to a collection of data used within a particular analysis. The term ‘data item’ is used when referring to a specific piece of individual data. These terms have been adopted for the present research.

Data sets

Four data sets were gathered during the research: classroom observations, participant evaluation ratings from staff, participant evaluation ratings from students and researcher notes. Summaries of the data gathered are detailed below.

Classroom observations

Table 6.2 details the classroom observation sessions that took place, and provides general notes on the organisation of the sessions.

Class	Date (2009)	Teacher and notes	Size of class	No of codes (initial)	Video time (m/s)
10C/ FR1	16/09	Teacher C (supply) *The first lesson was planned to be taught by Teacher A, but unfortunately they could not attend at the last minute, and so a supply teacher was brought in in her place. Teacher A could be considered as highly computer literate, Teacher C was not so comfortable with technology, and as a supply teacher was not as embedded in the details of the research as Teacher A. Nevertheless they were happy to run the lesson using Teacher A's materials and the software as intended.*	20	24	31:33
9X/ FR1	16/09	Teacher B *In this session students had written content ahead of time, in order to practice speaking it with the help of the technology.*	27	8	23:48
10C/ FR1	30/09	Teacher A *In this session the teacher had other issues to cover, so the time available for working with the technology was limited.*	19	3	12:48
9X/ FR1	30/09	Teacher B *During this session the bulk of class time was dedicated to working either on paper or using a computer based paper simulator, e.g. Microsoft Word, as preparation for adding content to the visual communicator software, hence very little observation could be made of students interacting with adobe visual communicator.*	29	4	03:53
10C/ FR1	14/10	Teacher D (supply) *This session was taught by a supplier teacher unfamiliar with the research and hence they were not familiar with its purpose.*	10	9	38:53
9X/ FR1	14/10	Teacher B *In this session students were tasked with creating and discussing school rules, both real and imagined.*	32	5	20:36
10C /FR1	04/11	Teacher A *In this session students worked in groups to improve their speaking skills.*	22	8	36:17

9X/ FR1	04/11	Teacher B *The students' task was to focus on use of the future tense, using their speaking skills to revise their knowledge. It was noted that there was a lot of chatting in this session, and a lack of focus overall on the task in hand.*	24	1	34:14
10C /FR1	18/11	Teacher A *In this session students worked in groups to improve their speaking skills, practicing for their oral exams. A group of girls was chosen for observation.*	20	8	23:22
9X/ FR1	18/11	Teacher B *In this session the group chosen for observation were not motivated, and became 'bogged down' in minor issues and playing rather than the task at hand.*	28	1	20:52
10C /FR1	02/12	Teacher A *In this session students were tasked with completing the scripts that they had been working on, and to 'publish' them, i.e. create a separate instance of their work as a complete video file for sharing. The students under observation closed down the computer after only a few minutes work, and it is unclear from the video as to precisely why.*	19	1	14:01
9X/ FR1	02/12	Teacher B *In this session students were tasked writing scripts describing their families and practicing their speaking skills.*	30	9	28:30
10C/ FR1	16/12	Teacher A *In this session students were tasked with practicing their speaking skills.*	18	8	20:45
9X/ FR1	16/12	Teacher B *In this session students were tasked completing their work started in the previous session, describing their families and practicing their speaking skills.*	31	9	21:09

Table 6.2: Classroom observation summary data

Participant evaluation ratings (staff)

Participant evaluation ratings from the staff involved were collected using teacher reflection sheets handed out at the end of sessions. These seemed effective in providing a simple baseline of data for each session, though the level of data gathered could perhaps have been richer. Interviews were originally planned with the teachers, with the purpose of further enriching the data gathered through these sheets, but unfortunately this became impossible due to other changes. These changes are described in more detail later.

Data summarising the ratings as provided by teachers leading the individual classes is provided in table 6.3, below. Slightly above average ratings were given overall for the rating evaluating how much the students have learned, and for the impact of the technology.

Class	**Date (2009)**	**Teacher**	**Technical issues with the ICT have caused ... (1-7)**	**The students have learned ... (1-7)**	**The use of ICT has ... (1-7)**
10C/ FR1	16/09	Teacher C (supply)	4	4	4
9X/ FR1	16/09	Teacher B	3	5	7
10C/ FR1	30/09	Teacher A	5	4	3
9X/ FR1	30/09	Teacher B	4	4	5
10C/ FR1	14/10	Teacher D (supply)	4	4	5
9X/ FR1	14/10	Teacher B	4	6	6
10C /FR1	04/11	Teacher A	2	4	5
9X/ FR1	04/11	Teacher B	5	5	6
10C /FR1	18/11	Teacher A	2	4	5
9X/ FR1	18/11	Teacher B	2	6	6
10C /FR1	02/12	Teacher A	3	4	4
9X/ FR1	02/12	Teacher B	4	5	4

10C/ FR1	16/12	Teacher A	7	4	3
9X/ FR1	16/12	Teacher B	3	6	6
Average			*3.7*	*4.6*	*4.9*

Table 6.3: *Summary data for participant evaluation ratings (staff)*

Participant evaluation ratings (student)

Student star cards provided a useful baseline for comparison with other data, and were particularly successful in their form as designed, in terms of being easy to use and providing the students with a flexible way in which to share their experiences. One unintended consequence of the free form design and use of the cards was that students tended to fill these in using half marks or even less, which was never intended, but this did add an extra level of detail to the data gathered. It demonstrated an interesting flexibility of use which has parallels with how the technology itself was used.

The data gathered using these cards, as depicted in Figure 6.11, showed a bimodal distribution pattern, with peaks at zero and three. Analysis of when the zero ratings were given seemed to show that this was most common when the technology failed, so this slightly unusual distribution is almost certainly explained by instances where the laptops were not working correctly, and hence the students feeling they were not learning anything.

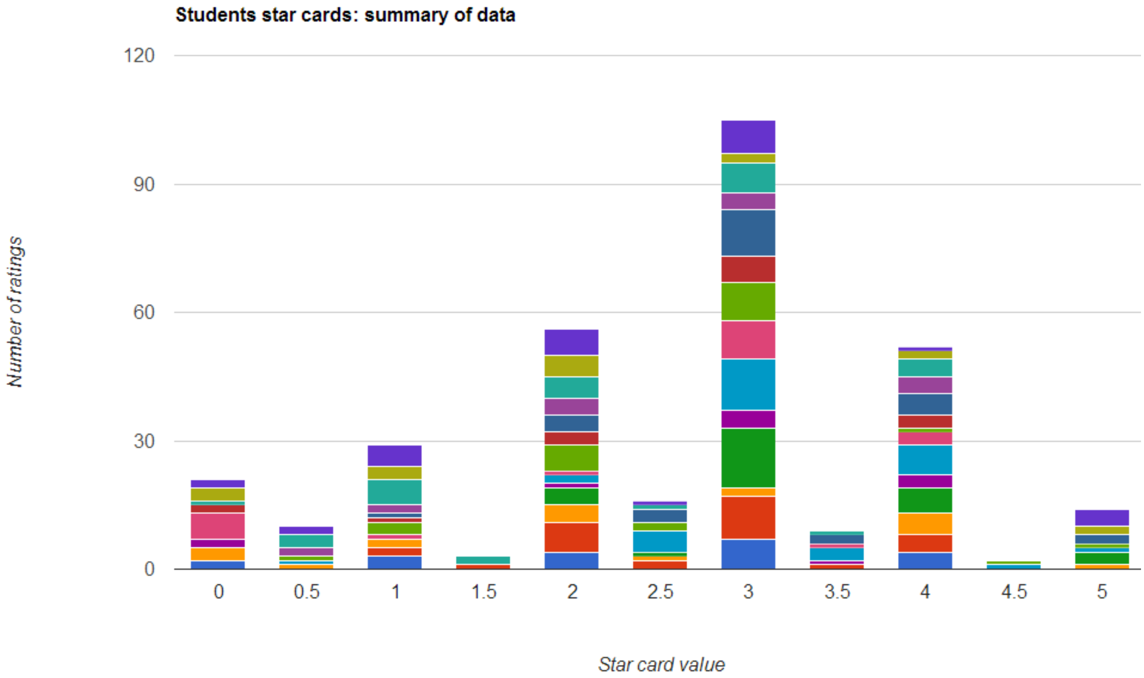


Figure 6.11: Histogram summary of student star card data

Analysis of quantitative data

The reason for gathering this quantitative data was to allow a degree of comparison between research instruments, which might help in explaining and/or corroborating anomalies in the data, a form of triangulation. In order to do this, statistical analysis was performed on the data sets in order to look for correlations between participant evaluations, most importantly to see if student and staff evaluations of the impact of technology tallied.

Figure 6.11 visually suggests that the data gathered using student star cards was parametric. If this is true for all the quantitative data sets gathered then it should be possible to perform analysis using the Pearson product-moment correlation coefficient, in order to see if there is alignment between responses given by the teachers and students. Developed by Karl Pearson in 1895, the Pearson product-moment correlation coefficient measures the dependence between two variables, returning a value between +1 and −1 inclusive. A value of +1 would indicate total positive correlation, 0 no correlation, and −1 total negative correlation. Within these ‘perfect’ scores of +1 and

-1, what counts for a strong, moderate or weak correlation is widely debated. Dancey and Reidy's (2004) have proposed a ranking against values returned by the test, which can be seen in Table 6.4, below.

Value of the Correlation Coefficient	Strength of Correlation
1	Perfect
0.7-0.9	Strong
0.4-0.6	Moderate
0.1-0.3	Weak
0	Zero

Table 6.4: Dancey and Reidy's (2004) categorisation of Pearson

Whether or not the data gathered is parametric, i.e. normally distributed, can be tested using the Shapiro-Wilk test (Shapiro and Wilk, 1965). Provided the results are above a significance value of 0.05, they can be considered as normally distributed. The data sets were loaded into the SPSS statistical analysis package, and the Shapiro-Wilk test was run on the four data sets in question, results are displayed in Table 6.5, below.

Data set	Significance
Technical issues with the ICT have caused ... (1-7)	0.107
The students have learned ... (1-7)	0.001
The use of ICT has ... (1-7)	0.308
Student Star Rating (1-5)	0.091

Table 6.5: Shapiro-Wilk test

This analysis shows that for all of the data sets except “The students have learned ... (1-7)” the distribution does appear normal, and therefore analysis using Pearson should be valid for these data sets. Tests were therefore run comparing the data from both types of participant evaluation ratings, the results of these tests are displayed in table 6.6:

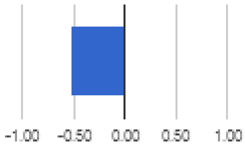
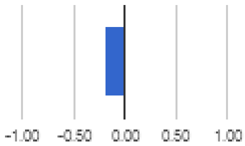
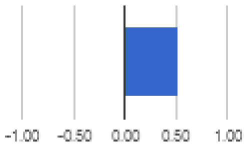
Participant evaluation	Pearson coefficient	Participant evaluation
Technical issues with the ICT have caused ...	-0.52 	The use of ICT has ...
Technical issues with the ICT have caused ...	-0.19 	Student Star Rating
The use of ICT has ...	0.53 	Student Star Rating

Table 6.6: Pearson product-moment correlation coefficient between participant evaluations

According to Dancey and Reidy's (2004) categorisation, moderate effects can be seen linking the use of ICT with learning. As might be expected, negative correlations were returned when comparing the impact of technology failure on learning (the ‘technical issues’ question is a reversed Likert, hence the negative values). Positive correlations linked the use of technology, how much the students had learnt from the teachers’ perspective, and how much the students and learnt from a student perspective. These correlations suggest the technology was playing a positive role in the overall learning that was taking place. It is perhaps particularly revealing that the strongest correlation is between the two independent variables from staff and students. The question “The use of ICT has (enhanced the students learning)” and student star ratings had the strongest correlation of 0.53.

Researcher notes

Researcher notes were kept to summarise important events as they took place in the sessions. Detail from these notes has been added to other data analysis sections as appropriate, as they cover a wide range of issues, from changes to technical set-up, to observations and thoughts on the learning taking place.

An example research note is included below in Figure 6.12. A blank example of the research notes is included in Appendix I4, and the full set of research notes is included in Appendix A5.

Research Notes for Visual Communicator Project

Class (inc. time & date): 10C / Fr 1 (9:00, 18/9/09)

Teacher: [redacted] & TA) ([redacted])

Technical Issue Score: 4

Students Learning Score: 4

Use of ICT Score: 4

Number of pupils: 20

Total 'Star' Score: 48

Objective of lesson:

Equipment being used: 10 Laptops & webcams

General Notes on Session:

Laptops very slow to start up.

Webcam set-up needs to be shown.

Video camera pointing at laptop better?

Log off / Log on problems? (No software showing on launch apparently [illegible] wide issue?)

Very gender split - girls work separately and boys work together

Research Notes Page 1

Figure 6.12: Example of a researcher note

Coding

Braun and Clarke (2006) recommend that the first stage in thematic analysis, before coding has begun, is familiarisation with data. As I collected the data personally I was already somewhat familiar with it ahead of time, but the tool used to collect the data was purposefully left in situ in order to collect data independently, and hence gathered a large amount of data which I would not be aware of. All the video data gathered was therefore watched first without any attempt at coding, in order to familiarise myself with the data as a whole. Memos were made during this process in order to gather general thinking about the events being observed.

Initial coding was then carried out, driven by the dialogic interaction between the research questions and the data. Coding was focused primarily on the students interactions with the digital environment, and what the environment was providing/furnishing for the students (i.e. the affordance of the environment), though codes were also created about other interactions and events. As Braun and Clarke (2006) state, “you never know what might be interesting later” (Braun and Clarke, 2006, p. 17). An example of this initial coding is provided below, in Figure 6.13. Times when the students were distracted or off task, e.g. when being addressed by the teacher or engaged in personal discussion, were not coded, hence the blank areas with no coding stripes.

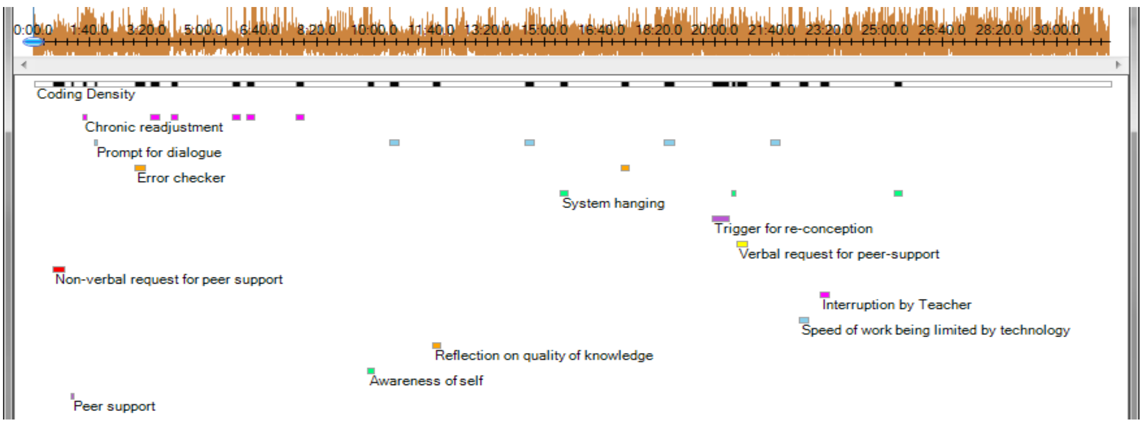


Figure 6.13: Coding example from NVivo

The next two steps recommended for thematic analysis are identifying and reviewing themes. This was done within the CAQDAS package, going back through the data and comparing instances of codes as they had been used, grouping and theming codes and attempting to reduce the number of codes into common types where possible. This process produced a ‘tree node’ (a term used by NVivo to describe grouping of codes) of ‘externalised cognition’, which contained three sub-codes. Their occurrence and frequency are provided in Table 6.7:

Code	**No of sources**	**No of references**
Error checker	7	12
Prompt for dialogue	10	18
Trigger for re-conception	3	3

Table 6.7: Summary of ‘Externalised cognition’ tree node

‘Error checker’ was a code used to describe scenarios in which the technology appeared to be the catalyst for students spotting mistakes in their work. This would happen either during creation of texts or during speech practice, and typically was an instant event with little or no dialogue, it appeared mistakes were obvious once rediscovered in this way. An example of this in practice from Group 2 (December 16th) is depicted in Figure 6.14, below.

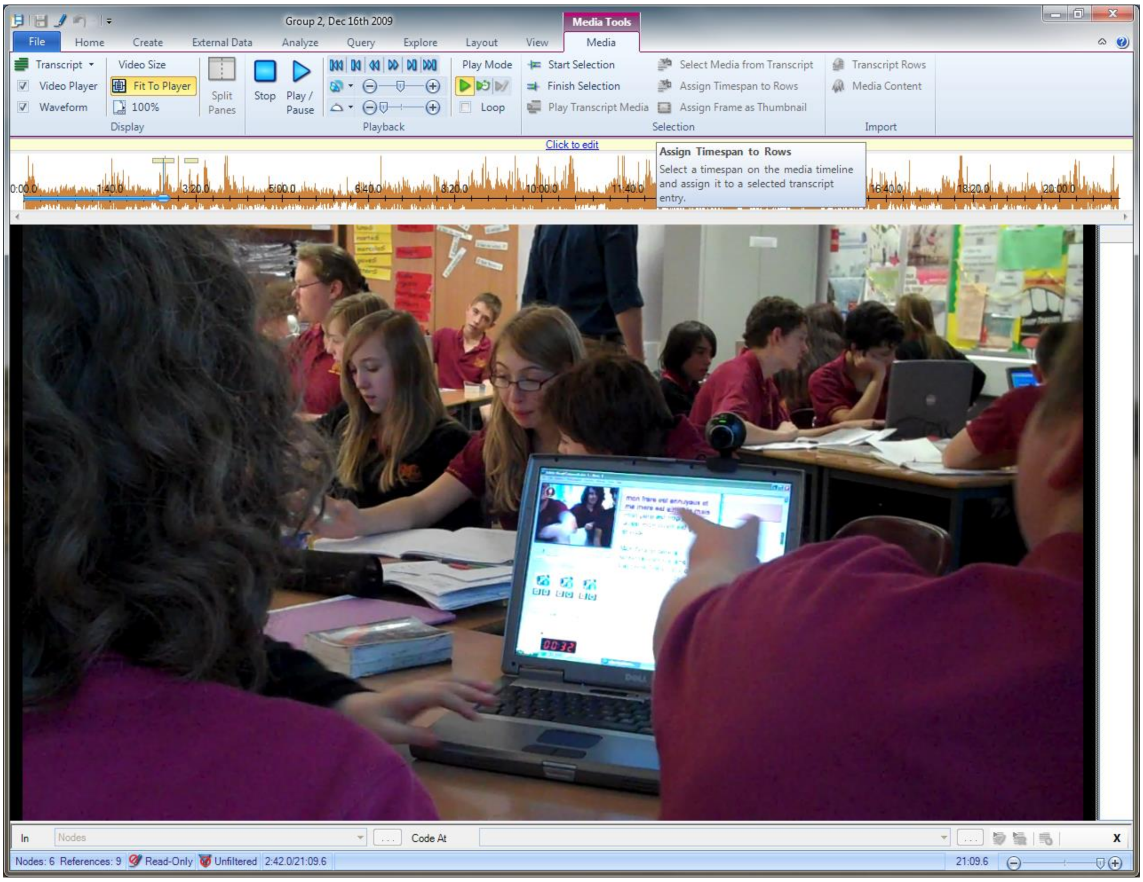


Figure 6.14: Example of the code 'Error checker', a student spotting a mistake in the text and highlighting this to peers

'Prompt for dialogue' was used to describe moments in which the technology appeared to trigger discussion between students, usually when a student who was not in control of the keyboard spotted something on the screen that began a dialogue. An example from Group 2 (September 16th), visually depicted in Figure 6.15, was when a block of text written in French triggered discussion between the students as to "Why do you like it? Why do you like drama?". The students' dialogue was in English, but they were discussing French text, this short passage led to the student questioning realising that they had misunderstood some of the French in question, and hence clarified their own thinking.

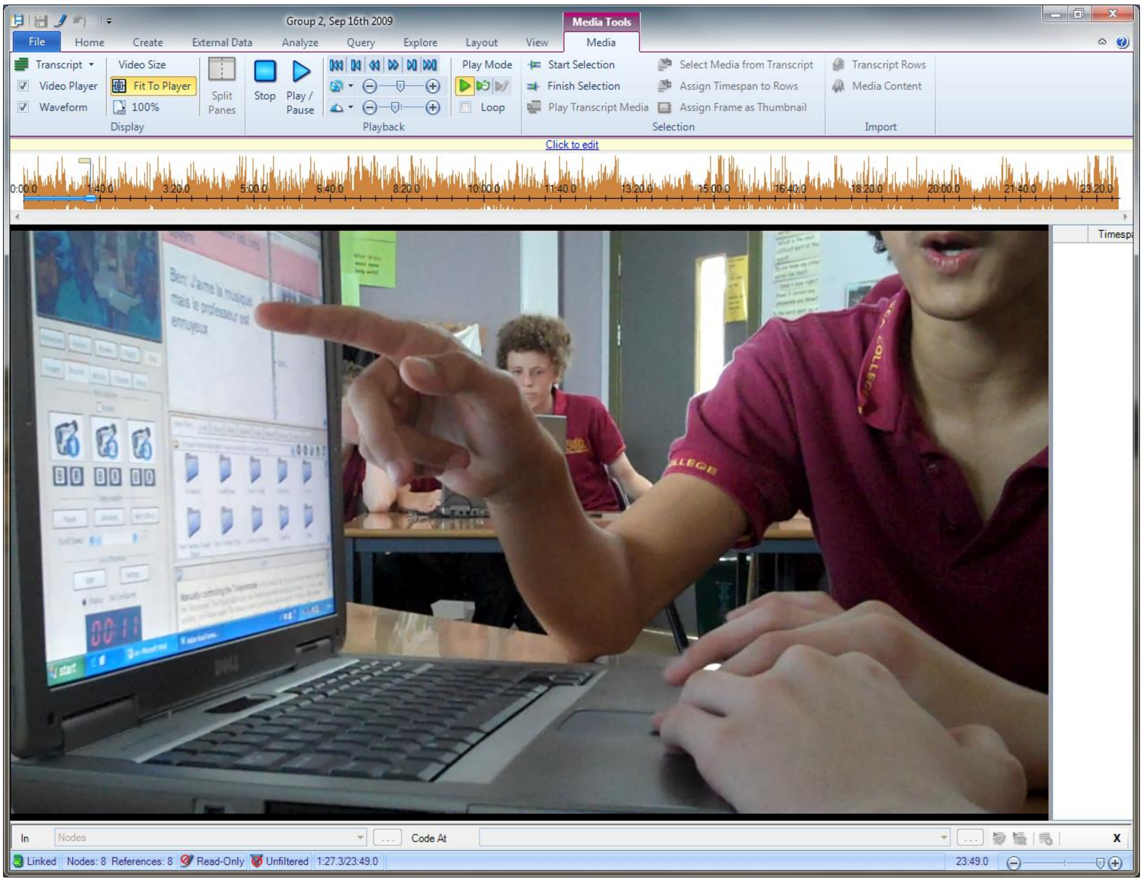


Figure 6.15: Example of the code 'Prompt for dialogue'

'Trigger for re-conception' was used to describe a shift in thinking, usually from the student in charge of the keyboard at the time. An example from Group 1 (October 14th) was when the student was heard to exclaim "Why did I write that?" when reflecting on an earlier piece of work, which then prompted them to revisit the text and prompted a new set of writing. It suggested something broader than simple error correction.

Another emerging set of tree nodes from the research was that of 'technology failure'. By establishing a separate tree node for this, these types of codes could be 'pulled out' of the main set of coding, separating effects of technology failure from effects of technology more generally. These codes and their occurrence and frequency are listed in Table 6.8

Code	**No of sources**	**No of references**
Camera not working	2	2
No recorded video or audio	1	2
System crashing	2	6
System hanging	6	8
System restarting	1	1

Table 6.8: Summary of ‘Technology failure’ tree node

Other coding did not form a coherent theme, with the exception of a strong pattern for events coded as ‘chronic adjustment’. This described a moment interacting with the software where the way that time was displayed back to the students was altered in some way, in order to meet their needs at that moment. This might take several forms, including adjusting the settings of the timeline itself to make it flow faster or slower, adding extra spaces into the timeline to change the flow of text that way, or dragging rapidly up and down across the text to compare separate passages of writing or review progress. A screenshot of this in practice is included in Figure 6.16 (the blurring is intentional, caused by the rapid motion of the timeline), and its occurrence and frequency are shown in Table 6.9, below.

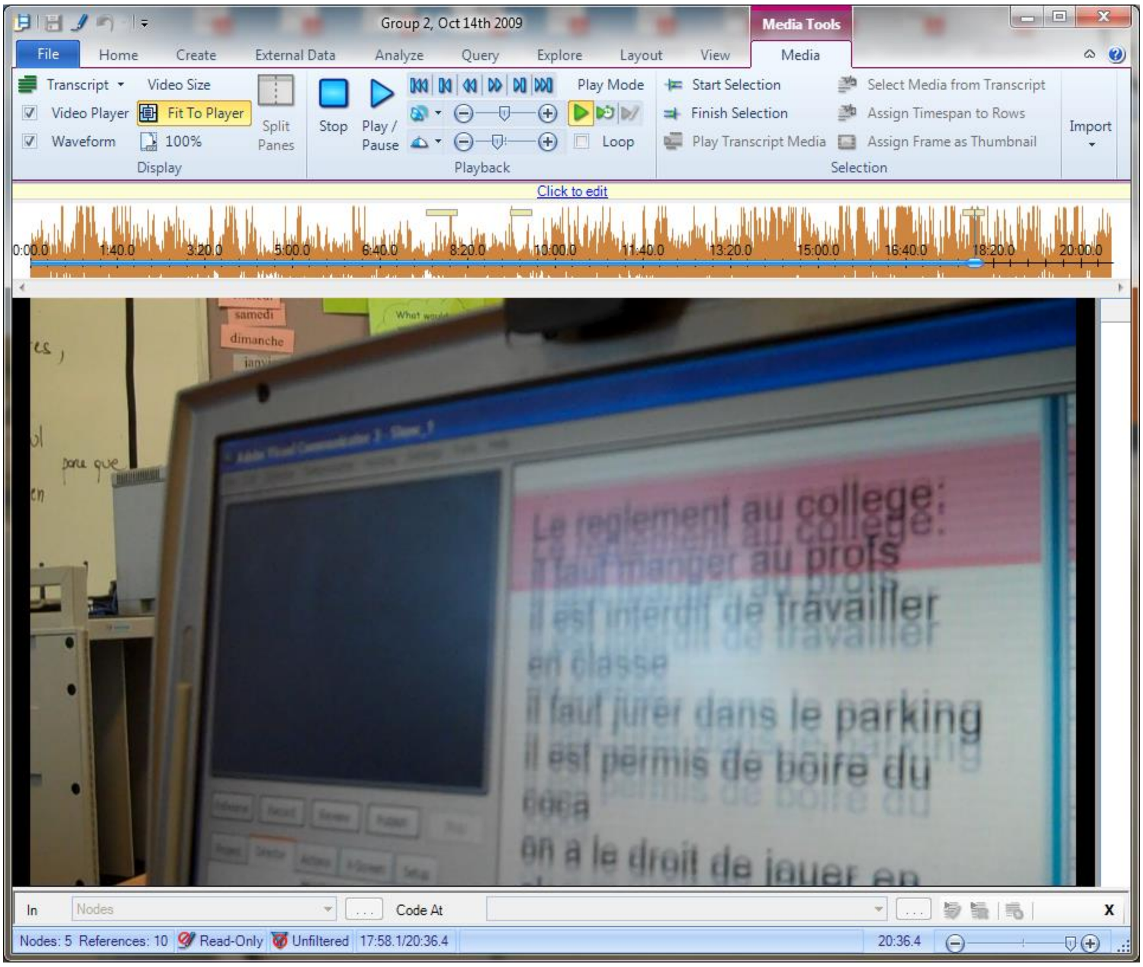


Figure 6.16: Example of the code 'Chronic readjustment'

Code	**No of sources**	**No of references**
Chronic readjustment	5	13

Table 6.9: Summary of 'Chronic readjustment' node

Remaining codes, and their occurrence and frequency, are listed in Table 6.9, below:

Code	**No of sources**	**No of references**
Awareness of self	4	4
Configuration of external resource (image)	1	2
Exploring capabilities of the technology	1	1
External observer (criticism)	1	1

Indication of Flow	1	1
Interruption by Teacher	1	1
Non-verbal request for peer support	1	1
Peer correction	1	2
Peer support	1	1
Positive group reflection	1	1
Reassuring participants	2	2
Reflection on quality of knowledge	1	1
Request for peer action	1	1
Search for external resource (image)	1	2
Speed of work being limited by technology	2	2
Teacher correction	2	3
Technical configuration	2	2
Technology as fun	1	1
Use of digitally embedded cognition (Google Translate)	1	1
User error - close without save	1	1
Verbal request for peer-support	3	3

Table 6.10: Summary of free nodes

Thematic analysis

The next step in the thematic analysis approach is the definition and interpretation of the themes as derived from the coding process. This section describes the themes that emerged from research at School A, based on the coding as described above.

Intention prescribing affordance

This theme summarises how the specific pedagogic context that the students found themselves in, that is the particular teaching scenario and the learning challenge that was presented to them during an individual lesson, appeared to drive the selection and different use of particular affordances of the same technology. How context appeared to prescribe or direct student intention, which in turn directed which affordances were attended to.

Once the first two stages of analysis, familiarisation with data and initial coding, had been completed, potential themes were selected and reviewed. Bryman (2012) suggests that an ‘emphasis on repetition’ is a useful way to begin to identify themes, though cautions against a direct match. Whilst many uses of the same codes may *suggest* an overarching theme, it “must be relevant to the research questions or research focus” (Bryman, 2012, p. 580).

Whilst reviewing the many codes under the tree node ‘externalised cognition’, it was suspected that different types of activity in the students appeared to lead to different codes. What was noticeable was that the students focused on those areas of the software which had most relevance to them for their specific learning needs at a point in time, and ignored others completely. Adobe Visual Communicator is a complex piece of software, with many different functions and abilities that might have been attended to, but the students were using it in very focused and specific ways. This would be in line with the principle of interpretive flexibility (Pinch and Bijker, 1984), in that the learners are only focused on what they *need* from the software, i.e. the affordances as related to their intention at that point in time. Many other affordances, e.g. the ability to add imagery, to browse external websites, to add transitions, etc., are not needed and hence appeared to be ignored by the learners within a specific session.

For example, in one session (Group 1, October 14th) a pair of girls were chosen for observation. They spent most of the class time working with real word textbooks, and discussing issues of vocabulary, and used the digital place provided as a repository for the results of that discussion, as opposed to a reflective space for creation. During this session the digital space appeared to act more as an ‘error checker’, where additions made to the space by one of the students prompted discussion over the correctness of the digital artefact that was added. In a similar session (Group 2, December 16th) later in the research, where students had now produced extensive scripts and were very competent at speaking these, it was again observed that the digital place had become less a place for creation and more a place for prompting and practicing speaking skills. Some use of the place as a prompt for dialogue was observed, with the digital artefacts as created by the students previously focusing and framing discussion, but more often it once again acted as an error checker allowing the students to spot mistakes in their work. Instead of being a creative space for exploring ideas and experimenting, the software had become a place for checking previous work, for reflecting on learning up to that point.

In contrast, some other sessions seemed to be much more exploratory and ad hoc in terms of rapid creation and destruction of content. In these sessions, where more time was spent writing scripts rather than using the digital place to practice speaking, coding seemed to reveal the digital place acting as a prompt for dialogue between students. For example, a pair of girls (Group 1, November 4th) was chosen for observation who were writing interview questions. The creation of the digital artefacts, in this case snippets of French language in the form of questions and answers to questions to reflect the thinking of the participants, prompted continuous iterations of reflection and change within that content. The same invariant aspects of the technology could be said to be providing different affordances driven by the specific intention of the students.

In one session students took advantage of the ability of the software to include static imagery alongside audio and video. What is perhaps interesting about this fact from a research perspective is not so much that these students did take advantage of this affordance, but that others did not. Is it suggested that this is again due to need /

intention, the context within they were working. The first research question asks what role need or intention plays in both the detection and use of affordances, as Gibson argued that need dictates what affordances are attended to. In general the sessions focused on describing various situations using language and then practicing speaking, the focus was entirely on the language used and hence perhaps descriptive imagery was not foremost in the students' needs. Why precisely these students decided to use imagery is difficult to interpret from the video, but they were tasked with describing their families. In this case they appeared to be describing themselves, and the imagery was chosen to represent each other. One of the girls chose a cat as their image, and one of the boys a dog. The need in this case was therefore this desire to find some form of avatar for the individual learners.

In order to explore this notion of intention driving use further, it was decided to try and code an entire source with a single code that described the overall pattern of behaviour during that learning session, and run queries to compare this overarching code with the other codes already derived. Rather than invent new codes for these overarching codes, Kolb's (1984) cycles of experiential learning was used as a basis for new codes.

Kolb's cycle was chosen as there seemed a natural fit between the types of reflective behaviour as observed in some speaking sessions in contrast with the more active work in other settings where text was being created. Kolb's (1984) model is an experiential learning model, part of a broader theory on learning which has often been cited as a model that encapsulates the learning process. It is depicted in Figure 6.17, below.

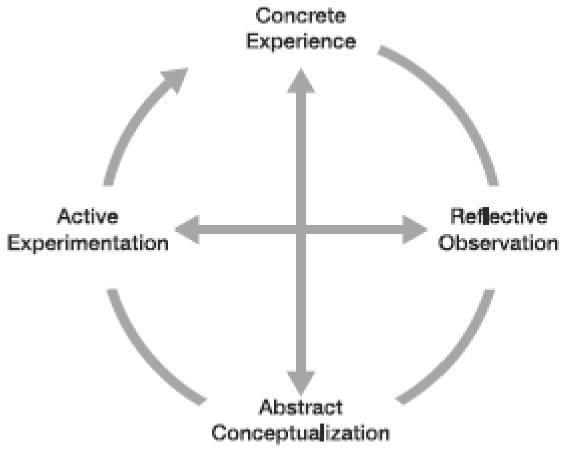


Figure 6.17: Kolb's experiential model of learning (from Dennison, 2012)

Whilst the model has had wide uptake with educational research circles (Dennison, 2012), it has been criticised on several levels. Bergsteiner, Averya and Neumann (2010), for example, suggest that the graphical depiction is in itself is a weakness of the model. Nevertheless, although empirical evidence for Kolb's cycle may be weak (Jarvis, 1987; Tennant, 1997), it does still appear to summarise important stages within learning, whether or not they appear in the prescribed cycle, and as such offers a useful model with which to frame a particular learning context.

The four stages of Kolb's (1984) model of experiential learning: abstract conceptualisation; active experimentation; concrete experience; and reflective observation, were used to create four new codes that were then assigned to each observed learning session based on the most common types of activity observed. The matrix showing results of this additional coding, comparing the Kolb codes with the existing codes, is displayed in Table 6.10, below:

	Chronic readjustment	**Error checker**	**Prompt for dialogue**	**Trigger for re-conception**
Abstract conceptualisation	0	0	0	0

Active experimentation	6	4	9	2
Concrete experience	1	0	3	0
Reflective observation	6	8	6	1

Table 6.11: Kolb coding compared with observation coding

The two highlighted cells show the two highest incidents of coding, and indicate a skew between the digital place acting more as an error checker in one learning condition, and more as a prompt for dialogue in another learning condition. Whilst not conclusive in terms of the skew of coding, the comparison of codes shown in Table 6.11 does show a stronger weighting for dialogue and re-conception during active experimentation phases, and a stronger weighting for error checking during the reflective observation. This does support the overall observation that intention is driving affordances, that students are taking advantage of different affordances at different times, even given the same invariants within the software.

What is perhaps particularly striking about the concept behind this theme is that it appears to be *unconscious* selection of affordances, based on intention, what might be termed passive affordance. The students had a particular challenge within a session, and they seemed to attend to the affordances most relevant to that challenge automatically and unconsciously. It is underlying tenet of ecological psychology, and the ecological perspective taken within this research, that experiences occur in a symbiotic and ongoing process of transaction with the environment, an individual is seen not simply as controller of the space within which they exist, but also to a certain extent being ‘controlled’ by events or situations within that space, events or situations which come to pass through no action of their own. This appeared to be the case with students as observed, they were not always defining exactly what they wanted to get out of the digital place, they were adjusting what affordances they used based on their needs as dictated by the learning scenario. Affordances were both active and passive.

This analysis also highlighted that the ‘chronic readjustment’ code was equally prevalent in both the active experimentation and reflective observation cases. This brings us on to the second theme, that of control of time.

Control of time

Coding revealed repeated examples where digital objects were created by the learners which then acted as triggers for reflection and reinterpretation of the actions of the group of learners. At the heart of the software is a time loop, a timeline which slowly progresses through user generated content that can then be followed and spoken aloud. On several occasions this slow progress of simulated time within the digital place acted as a trigger to spot inconsistencies or errors within previously created content, and the students were then able to go back and correct these errors. The memo below, written at the time of analysis, highlights an instance of this :

> *“During Group 1, Sep 16th, students realised through reflecting on the script (in this case actually adding an answer) that their conception of some of the language was wrong. "That means fruit and veg - I do like fruit and veg - I thought that meant seafood" led to writing a new answer. There might be something of a pattern here. I've seen mistakes go by and not be recognised by the students, but more often it happens that the constant cycling through the text means they pick up more mistakes and correct themselves, either their speech or their vocabulary.”*

This time loop within the digital place appeared to be the key invariant present across all activity. This invariance provided an affordance of ‘control of time’ for the students, highlighted by the use of the code ‘chronic adjustment’, where students would purposefully adjust the way time was played back to them in order to change the way in which the technology provided feedback to them. They were in effect manipulating their transaction with the digital place, stopping and starting the timeline, adjusting the flow of the timeline through extra spaces, or changing the rate at which the timeline moved. This affordance appeared to be both active and passive. For example, sometimes the timeline provided the ability to actively scan text to check for alignment between sections, what might be termed an active affordance; other times the automatic flow of time provided more of an error checker, what might be termed a passive affordance.

A minor event occurred at the beginning of one session, which I feel is worth reporting, as it inspired some reflection on this theme of control of time. An unknown woman's voice was overheard on the audio track commenting critically on the speed of work, in that the students seemed to spending a lot of time on creating text with the software. Her exact comment was “How long have you been working on that one? Because last time I came it was a month ago and you were doing this.” She did not seem impressed with what she perceived. The students were in fact using the software only once every two weeks, so a large chunk of time would have passed with little more progress on this specific task. However from the unknown woman's perspective the chronology of events would not have been clear. Why this is perhaps relevant is this personal relationship to time. For the unknown observer, time had passed and yet no progress had been made. There seemed to be the implicit thought that progress would have been made, even though the unknown woman could know nothing, or at least very little, about the structure of the classes and the learning. The students, on the other hand, seem happy and comfortable to return to the digital place relatively infrequently, and the fact that it remains just as they left appears reassuring enough that they continue more or less as if nothing had happened.

There is perhaps here a link to the concept of the chronotope. This term literally means "time space" and was coined by the Russian philosopher Mikhail Bakhtin. He defined it as:

> "the intrinsic connectedness of temporal and spatial relationships that are artistically expressed in literature"
>
> Bakhtin (1981, p. 84)

Bakhtin used the term as a way of thinking about how time and space were both altered but were also defined within literary works, how the sense of both time and space could be shifted by writers and blended into forms which were perhaps not possible in the real world, and how particular chronotopes defined genres and writers. In the present context the word is relevant, as the unknown woman seems to have a very different sense of time and space relative to the students. Potentially the digital place itself has a chronotope of its own, which is different to that experienced in the real place, one that the students have perceived and are comfortable with but the unknown woman is not. These thoughts will be returned to later.

Technology as place

Chapter 4 has argued that conceptions of digital space and digital place are useful ways of thinking about digital technology in education, in part because they can separate out the theoretical *space* from the realised *place*, and the different roles that interface versus place might provide for learners. The present context does appear to support this concept, as the digital technology was clearly acting as an extension of the physical reality of the classroom, and had become central to the learning that was taking place. Table 6.6 showed the strongest (negative) correlations between technology failure and learning, which confirms the central role which the digital place was playing.

Table 6.8, the summary of 'technology failure' tree nodes, has listed the occurrences of technology failing, but gives little insight into how the students reacted to these failures. Given the number of technical issues that were experienced, it might be assumed that it was difficult for students to learn using the technology, but apart from isolated cases this did not appear to be the case. Students appeared to be engaged with the exercise and persevered throughout any technical difficulties. There was a marked sense that technology was *expected* not to work very well, that the students were used to using computers that were slow and unreliable.

What was clear was how frustrating technology failure was. In session 10C/FR1 (16th of December 2009), for example, the students became very frustrated with the technology as they repeatedly tried to reach their digital 'place', they could see it briefly and knew that their work was intact, but then the technology failed and their work became unreachable once more. This appeared to be very annoying for them, as they seemed to be engaged with the learning and enjoying the challenge.

Findings

As has been explained at the beginning of this chapter, the research at School A was originally planned to run over several terms, but ultimately only one term of data gathering proved possible. Nevertheless, findings from this term have suggested ways forward. A summary of the data analysis is presented below, framed against the three research questions as defined in Chapter 5. Areas of focus for the next stage of research are proposed in each case, which together form the basis for an initial design framework.

RQ1: What role does intention/need play in the detection/use of affordances?

According to the theory of affordances as set out in Chapter 3, we live in a world surrounded by affordances. These affordances are nested within each other (Gaver, 1991), so that more complex affordances are embedded within - and in some cases arise from - simpler affordances. Gibson suggested that the affordances we actually attend to at any one point in time are based on need at that time, but does not provide much detail about how this happens in practice.

The intention or need as defined by the learning task for students at School A appeared to focus students on particular affordances of the digital place. The Adobe Visual Communicator software is a very powerful and complex digital place, and it has the potential to support many different types of interaction and activity within it, to provide many different affordances nested within each other. For example, it is possible to browse the web within the software itself, discovering and selecting images, video, and other online resources. Captions can be created and overlaid onto video streams, describing moments as they appear, along with text or graphic slides to introduce different sections. Green screen effects can be created, simulating the appearance of being at a different location. Although some of these are complex and might have required extra support, what was marked across all the observation sessions was that students ignored them. They tended to use the software in very similar ways, and in distinct ways based on their progress in the learning task that they were assigned. Their use appeared to be focused by intention, and although many appeared to be expert users of computers (for example, finding ways around blocking tools by using foreign sites, installing/running games through USB sticks or other backdoor type activities), their use of the Adobe Visual Communicator software was both focused and specific.

The coding using Kolb's experiential model of learning in particular suggests intention/need directly influenced the affordances that were attended to. For example, in early sessions under observation the students' main task was on building a body of French text which would serve as the basis for later speaking practice. They were focused on creating text, and here the key affordance that the digital place provided appeared to be as a prompt for discussions between students. In contrast, within sessions where students were more focused on practicing speaking, the digital place seemed to support a more reflective stage of learning, with the students used the ability to manipulate the way time ran within the digital place to help frame their attempts at speaking the text that they had previously created. The technology appeared primarily to provide a simple error checker, helping them to spot mistakes in their work as they practiced their speaking. In both contexts the digital place reflected back to learners their thinking in real time, 'mirroring' their work together, but the context was shifting which particular affordances were most attended to.

From a learning design perspective this is interesting because it suggests close attention to what is being attempted from a pedagogic point of view, i.e. the pedagogic context driving intention, could potentially define what invariants of technology could provide the affordances most able to support that intention. For example, if dialogue was the key pedagogic requirement in an early stage of an ongoing learning scenario, then invariants could be sought which would match that need, underlying invariants of a digital place that might support dialogue such as the ability to post and receive comments. If in contrast reflection was deemed to be more beneficial at a later stage in that learning scenario, so invariants might be identified to support that process, perhaps those that provided the ability to browse through historical content. The suggestion is that a framework linking these two, intention and invariant, might be created ahead of time, and therefore the most appropriate technology, i.e. the technology which could provide affordances to support the learning task, might be aligned ahead of time. This therefore suggests the first focus for research, better definition of intention in the form of educational context, with a view to using it to align digital technologies.

Chapter 3 argued that affordances should be understood as a trinity: of invariants (representing the objectivity of the world); intentions (representing the subjectivity of the individual); and the 'space of possibilities' of affordances linking these two. It introduced a diagram that attempted to visualise this trinity (Figure 3.5, p. 82). This trinity also suggests a model for the design framework, in terms of the three aspects of affordances that need to be addressed if affordances are to be used as a design tool to align pedagogy and technology. Figure 6.18 shows an updated version of this trinity, which now includes this first focus from the research at School A, that of better definition of intention in the form of educational context, which begins to build this initial design framework.

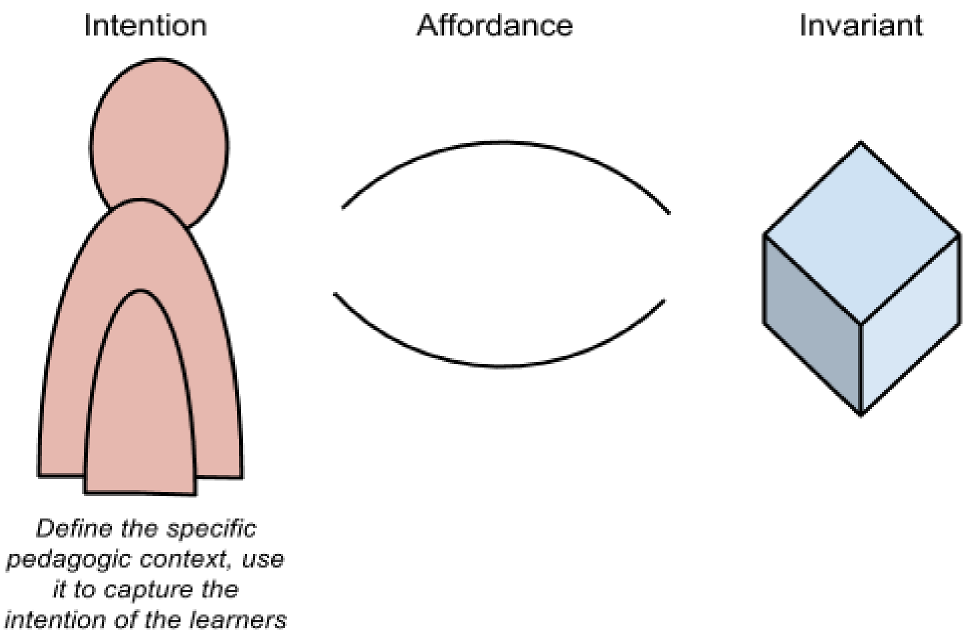


Figure 6.18: Affordances trinity / initial design framework including findings from RQ1

RQ2: What invariants within digital technologies make affordances possible?

What was striking about the current phase of research from an invariance perspective was the perceived difference between invariance at the interface level and invariance at the place level. Chapter 4 has made the argument that these are separate, and that place can identified as separate from interface, and this appears to have been the case in this context.

There exist invariants in the layout and the functionality of buttons and other interface objects within Adobe Visual Communicator which gives users control over the place itself, they provide the standard ‘action possibilities’ that HCI designers would expect. But beyond these interface elements there appears to exist invariance in the manner in which the place itself behaves that can also be perceived and learnt, and give rise to affordances of its own. For the Adobe Visual Communicator software, the strongest invariant appeared to be the ability to store thinking in a timeline that could be then played back to the learner providing a mirror of their own understanding. This feature had all the hallmarks of invariance, in that it was both stable and reversible, and acted as a catalyst, i.e. it was not changed in itself as a result of student actions. Sometimes students used this timeline to rapidly scan up and down within text they were creating, seemingly checking their overall structure and narrative prompting dialogue, in what might be termed an active affordance. Other times they let the timeline glide past automatically containing their written texts, using it to frame their speaking, and helping spot errors in their work, in what might be termed a passive affordance. In both cases the invariant was the same, but the affordances were different.

This invariance of place is related to the invariance of interface, and to some extent depends upon it, but does appear separate. The timeline contained interface elements that allowed it to be manipulated, but it also defined the place in a way which remained invariant regardless of the interface elements. Those elements of the place which might be described using Gibson's words as its *substance* - its shape, its motion, the way that text was arranged within it, its ability to change cameras and graphics, etc. defined invariance of place. It had functional aspects which were invariant, and hence could give rise to affordances.

There are perhaps parallels here with the increasing prominence within the world of web design of the importance of user experience, or what has become known as UX. This is a different field to that of user interface, and as Figure 6.19 below shows, it appears to have become more widely discussed over the last few years. The data from this chart has been taken from Google Trends, a free service which looks at how popular search terms have been historically, data can be viewed globally or isolated to specific countries. The validity of this data for exploring wider social issues has been explored by some researchers, Mellon (2014) for example suggesting that provided the terms have sufficient ‘content validity’, i.e. that they accurately describe a *specific* domain, then they can be considered as providing reliable salience for a wider social issue.

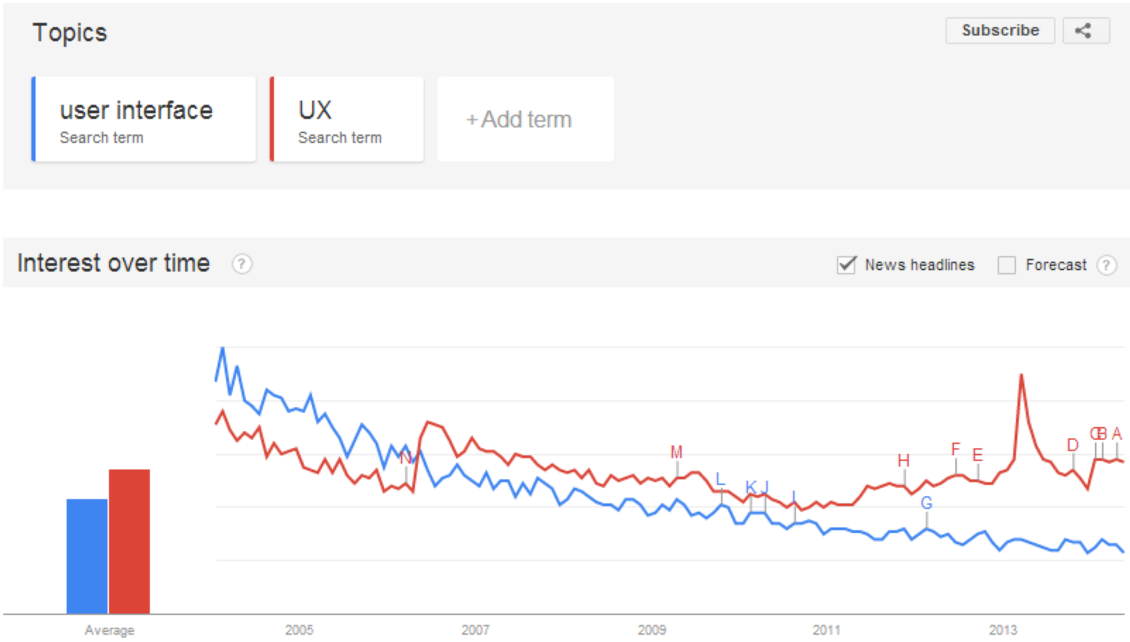


Figure 6.19: User interface vs user experience (UX)

(Google trends, last accessed 12/5/2014, available at http://www.google.com/trends/explore#q=user%20interface%2C%20UX)

User interface focuses on how the elements of an interface between user and computer are designed, perhaps synonymous with Gibson’s *surfaces*, whereas UX focuses on how the digital place itself is experienced, closer perhaps to Gibson’s *mediums* and *substances*. Figure 6.19 would suggest that this recognition of the importance of experience as opposed to interface, of what it means to be immersed within a digital place, as opposed to simply how to navigate through that place, is growing.

Invariance within a digital place appears to arise as a product of design choices when that digital place was created, and appears - in this context at least - to be specific to that digital place. The ability of the students to ‘pick-up’ and use this invariance to provide multiple affordances, without any training or guidance, was striking and in line with Gibson’s claim that affordances can be discovered and used “without an excessive amount of learning” (Gibson, 1979, p. 143).

Invariance is a prerequisite for an affordance, but crucially it does not define what that affordance might be. A large stone may have an invariant property of extreme heaviness, for example, but from an affordance perspective it could function equally well either as a nutcracker or as a door stop. Similarly, the invariance within the Adobe Visual Communicator software might provide either an error checker, or perhaps a trigger for re-conception, depending on the context and the need at the time. It is proposed that this is only possible because the technology being used is ‘interpretively flexible’ (Pinch and Bijker, 1984). It does not precisely determine how it is used, and hence it can meet different needs in different contexts. A ‘true’ nutcracker can do little more than crack nuts, it is technologically deterministic (Veblen, 1921) in that it has been designed for a specific purpose and can provide few if any other affordances. In the present context the flexible nature of the technology allowed students to match it to their learning needs, in a way which a more deterministic technology would have prevented. From an affordances perspective, therefore, the flexibility of the technology is an important feature that needs to be included in the design process in order to provide a wide range of potential affordances. This leads to the second focus that is proposed, the need to choose ‘interpretively flexible’ technologies that allow individuals to meet their specific needs. The trinity diagram of affordances is repeated below, with this additional focus now included, as Figure 6.20.

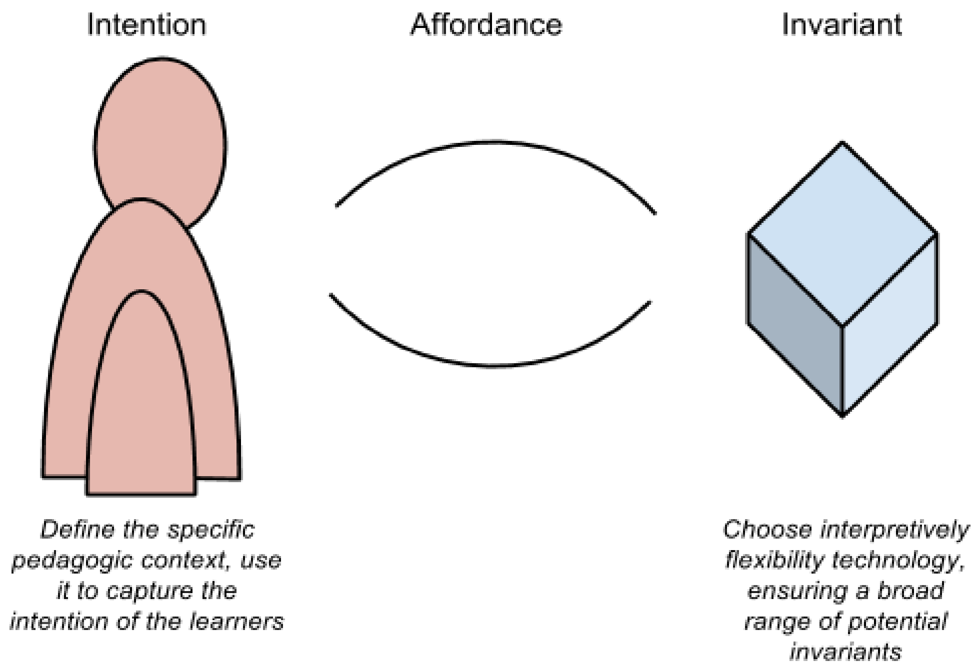


Figure 6.20: Affordances trinity / initial design framework including findings from RQ2

RQ3: What do learners receive from a digital technology, when used in an educational context?

The purpose of this research question is to try and focus on what individuals receive back from interactions with digital technologies. It has been argued that affordances are not simply about what actions are possible. The original definition suggested that affordances are about what something "provides or furnishes", so they must include a transfer back to the individual that takes advantage of them. Not so much an action, or even an interaction, but perhaps more of a transaction.

If a third party was to look at the finished products from the sessions, the scripts and the recordings that were made by the students, these might perhaps look rather trivial and insubstantial considering the time spent on them. What observations appear to have shown, however, is that the process of creating these products was much more valuable than the products themselves. What started to emerge over the course of the sessions was that the digital place provided by the Adobe Visual Communicator software appeared most powerful from a learning perspective as a place to create and then to reflect on what has been created, to *cycle* thinking. The most prominent codes clustered around the category ‘externalised cognition’, these were the codes related to error checking, peer suggestion, prompts for dialogue and triggering reconceptions. In all of these situations the digital place appeared to provide the catalyst for change; for a cycle of reflection that assisted students with their learning. A memo written during the research, an image of which is supplied in Figure 6.21, below, reports “Lots of review to reflect on progress”, and makes the point that “This is important - strong support for externalisation (of cognition), leads to greater understanding”.

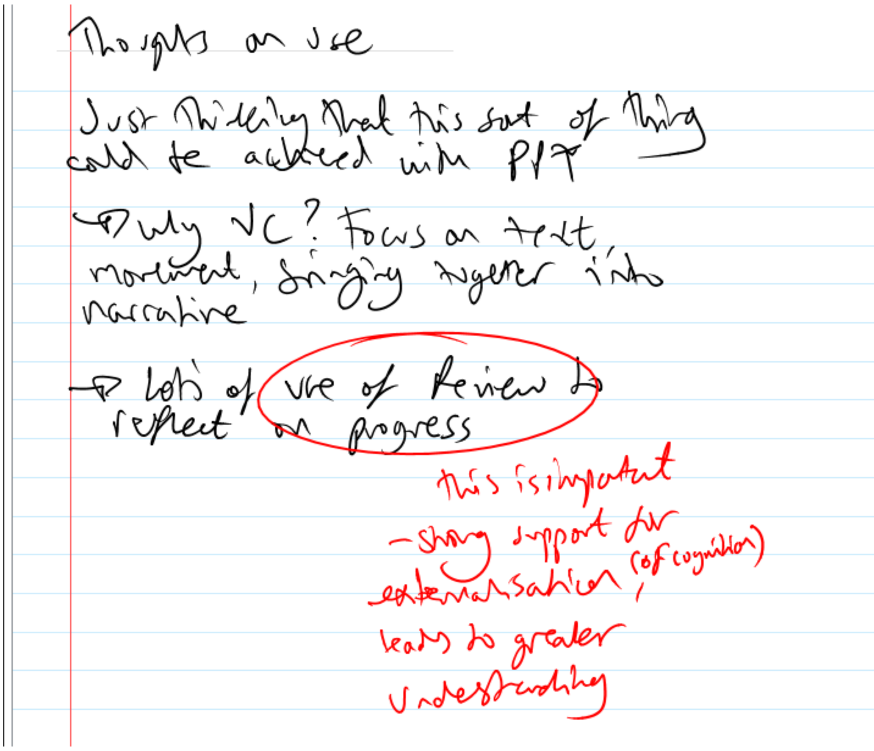


Figure 6.21: Memo on cycle of thinking

A key affordance of the digital place in this context therefore appeared to be its ability to act as a ‘mirror’ for the learners. It is perhaps worth noting at this point, that the use of the word affordances in this context is not attempting to identify the ‘action possibilities’ that students might take advantage of. Chapter 3 has argued that this way of viewing affordances is an unnecessary simplification of the affordances concept, which has become widespread mainly because of its utility in supporting interface design. This thesis has proposed that digital technologies provide digital places, and that these places provide affordances above and beyond those at interface level. A focus on action possibilities may be sufficient for studying the *interface* of digital technologies, but arguably it is not complex enough to help understand the *place* provided by digital technologies, the medium and substance. Instead the term affordance here is understood to be what the digital environment or place "provides or furnishes" in Gibson's original sense. From an 'action possibilities' perspective, the students need to actively engage with the digital place in order to take advantage of what it provides, what might be termed active affordances. In contrast, the original Gibsonian perspective allows for the digital place to provide an affordance for learners independently of any specific actions that they might take, in what might be termed a passive affordance. Simply by being immersed in the digital environment, using it as the space for learning, affordances were detected and attended to which originated in the place itself.

These findings about active and passive affordance suggest a further update to the trinity diagram, which is presented below as Figure 6.22, using arrows to indicate this flow back and forth between intentions and invariants, of active and passive affordances. This better represents the 'space of possibilities' of affordance, and that affordance is potentially not only about actions taken with the technology, but also about transactions exchanged with the technology.

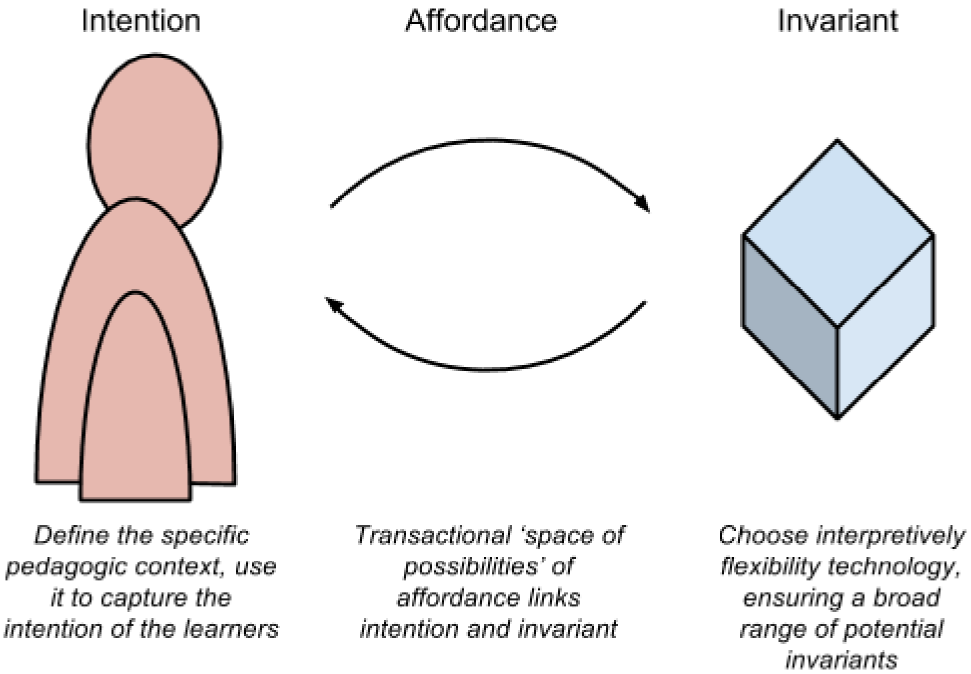


Figure 6.22: Affordances trinity / initial design framework including findings from RQ3

These findings provide an initial design framework extracted from observations of affordances in use at School A. It is a theoretical representation of how the trinity of affordances might potentially be actualised.

Summary

Chapter 5 has outlined how the overall goal of this research is to explore whether the theory of affordances can provide the theoretical basis through which digital technologies can be aligned with pedagogic goals. Edelson (2002) proposes that design-based research should work towards design frameworks, a “collection of coherent design guidelines for a particular class of design challenge” (Edelson, 2002, p. 114); the findings as outlined here against the three research questions have been matched with the trinity of affordances laid out in Chapter 3, using the affordances trinity as a “tool to structure inquiry”, in order to provide an initial design framework (Figure 6.22, p. 228).

The first part of this design framework, “Define the specific pedagogic context, use it to capture the intention of the learners”, is designed to capture intention, to constrain options and narrow down the possible range of matching digital technologies by providing a specific pedagogic context. Defining the key characteristics of a learning scenario ahead of time, such as the need for reflection or for dialogue, should enable the matching of specific technologies with that scenario. As the detection of affordances is linked with intention, so this should theoretically enable useful affordances to be detected and used by learners.

The second part of this design framework, “Choose interpretively flexibility technology, ensuring a broad range of potential invariants”, opens up the range of potential technologies in this pedagogic context, by suggesting technologies that do not prescribe use in themselves. By focusing on flexible technologies, where affordance is less closely tied to invariant, learners will have more capacity to discover and use affordances that match their needs.

The third part of this design framework, the “Transactional ‘space of possibilities’” that links intention and invariant has been observed in practice, but lacks clarity in how this might actually be designed into the framework. The framework is not therefore at this stage a practical tool that might be used to align pedagogy and technology, as this third part of the framework has yet to be developed.

The next chapter documents how this initial design framework was developed and completed in order to create a practical design framework. It describes how this initial design framework, which was derived from theory and from observing learning scenarios, was developed into a stable design framework through which to design new learning scenarios.

Chapter 7: Design Narrative, University of Exeter

"If at first you don't succeed, try, try again"
Thomas H. Palmer, American educator

Introduction

This chapter documents the research that was undertaken at the University of Exeter. It begins by describing the wider context that this research was embedded within, the Collaborate project, which explored how to develop student employability through assessment, supported by digital technologies. The main design narrative then describes the development of the three parts of the initial design framework from School A into a stable design framework to align pedagogy and technology: how intention was captured using a thinking tool to define pedagogical context, in the form of a dimensions model of authentic assessment; how invariants within suitable digital technologies that could be aligned with the model were identified using a set of digital playing cards, similar in style to the Top Trumps card game; and how a questioning technique was developed using Gibson's original conception of affordances as a guide for alignment, in order to identify the 'space of possibilities' of affordance that links these two. A meta-analysis of data gathered through iterations using this design framework in practice with participants is presented, and implications discussed in relation to the three research questions as outlined in Chapter 5.

Transition to Higher Education

Chapter 5 has described how the initial research plan had anticipated several cycles of research with School A, as depicted graphically in Chapter 5 (Figure 5.4, p. 138). Design-based research uses an iterative approach, designing interventions, studying their use, and then redesigning and adapting each iteration to produce further iterations, honing the overall design in the process. Unfortunately organisational and staffing changes within my employment precluded any further involvement with School A and therefore any further iterations. Design-based research requires close working with participants, and the research instruments that had been designed needed me to be present in the classrooms during research sessions. This type of extended contact, requiring me to be away from employment for long periods of time, was no longer possible. A new context and new participants were therefore required if the research was to continue, a context which could build on the initial design framework identified during work at School A.

An opportunity arose within the University of Exeter to become involved in a new long term project exploring the relationship between employability, assessment and technology, the ‘Collaborate’ project. The challenge of this project was to find methods to align these three areas of interest to the institution, to design new tools and techniques to assist those involved with teaching and learning to accomplish this alignment, and to work directly with participants in real learning scenarios to embed and test this in practice. The Collaborate project offered the opportunity to continue the research, as it directly matched the three areas of the initial design framework (Figure 6.22, p. 228):

- The need to explore intention in the form of methods of assessment appropriate for embedding employability in the curriculum. As assessment is widely appreciated to drive what students attend to within learning contexts (Gibbs and Simpson, 2004), defining assessment should directly influence intention
- The identification of the value of digital technologies within learning contexts, i.e. how invariants within particular digital technologies might best support

intention as defined within a designed assessment

- An implicit need to find a way of aligning this intention and invariant, to understand the transactional ‘space of possibilities’ or affordance provided by digital technologies given a specific pedagogic context

The project also matched well with the design-based research approach that was being taken, as it intended to develop theory through the study of the development and use of practical, sustainable products, developed in partnership with participants over an extended period of time. The project had no conceptual framework in place, and did not intend to base its work on any specific theory before I joined; it therefore seemed a good candidate within which to continue the research. The affordance trinity as outlined in Chapter 3, which proposed generic characteristics of intention, invariant and the ‘space of possibilities’ of affordance linking the two, is not tied to any particular age group or context, and so should be as equally valid at Exeter as at School A. Likewise conceptions of the digital environment were not tied to the context at School A, so should be equally valid in the new context at Exeter.

Joining the Collaborate project changed the dynamic of the research, in that I was now leading a project team working within the wider University context, and was responsible for the implementation of a project that already had a broad direction of work outlined. Fortunately I was able to join the project at a very early stage as the project manager, responsible for the overall design and running of the project. I was therefore able to write the overall project plan, designing the work packages and interventions, and as a result of this early involvement a design-based research approach was interwoven into the main objectives of the project, and the initial design framework from the research with School A was used to underpin key design choices for Collaborate.

Context

Design-based research is inevitably a messy undertaking, and can appear to be operating “at the edge of chaos” (Mor, 2011), making the type of replicability expected of experimental research difficult. As has been discussed in Chapter 5, using a design narrative approach is one potential way of addressing this problem (Hoadley 2002; Bell, Hoadley and Linn, 2004; Barab et al, 2008), by making explicit why certain design choices were made. One particular strength of the design narrative approach is that is provides “sufficient contextual information for those who wish to conduct a similar experiment” (Mor, 2011, p. 2). This section provides this contextual information, outlining the background to the Collaborate project, how it matches and leads on from the previous work at School A, and how it aligns with the overall goals of the research.

The Collaborate Project

The Higher Education White Paper ‘Students at the Heart of the System’ (Cable and Willetts, 2011) encouraged “closer working between institutions, employers and students to create a better experience leading to better-qualified graduates” (Cable and Willetts, 2011, p. 45). This was the focus of the Collaborate project. It was an ambitious project to introduce new generation assignments at the University of Exeter based around real-world and scenario based activities, designed collaboratively by programme teams, students and employers. The overall aim of the project was to ensure Exeter graduates were well equipped and work-prepared for their future role in a global economy.

Recognizing that assessment is one of the primary drivers for learning (Gibbs and Simpson, 2004) a priority was to link assessment with employability. However, it was also recognized that this is challenging task that no one individual can achieve alone. The project therefore intended to use a collaborative approach, supporting collaboration between programme and institutional teams, students and recent graduates, employers and other professional bodies. To this end it designed in collaborative relationships which were intended to focus on processes which had the potential to provide opportunities to use new technologies in creative ways. Chapter 5 has described how design-based research is a participatory form of research, where "practitioners and researchers work together to produce meaningful change in contexts of practice" (Design-Based Research Collective, 2003, p. 6). The project was therefore an ideal match for a design-based research approach, as it intended to work together with practitioners, designing new assessments in a collaborative and iterative manner.

Dissatisfaction of students with their assessment experiences (QAA, 2006) means assessment is a national challenge and it has led to a decade of priority investment in projects from organisations such as the Higher Education Funding Council for England (HEFCE), the Joint Information Systems Committee (JISC), the Quality Assurance Agency (QAA), the Higher Education Academy (HEA) and the National Union of Students (NUS). The Collaborate project drew on several key outcomes of projects funded by these institutions and others, in particular the principles of assessment developed by the NUS (NUS, 2010) and by the Australian Learning and Teaching Council (Boud, 2010), but was initially based on a model of 'tensions and challenges' relating to assessment described by Price et al (2011). These challenges exist along five separate continuums, and can potentially be seen as encapsulated within the collaborative framework of students, employers and programme teams as outlined earlier. This relationship is depicted graphically in Figure 7.1.

Figure 7.1: Tensions and challenges in assessment design: a collaborative approach

The project aimed to explore these continuums through an iterative cycle of audit, design and evaluation. It was initially envisaged that digital technologies would support the processes underpinning these principles, and that there would be an emphasis on exploring the role of technology in resolving the tensions implicit in each continuum.

The project was designed to be carried out in the form of eight work packages, each focusing on different stages of the project and cumulatively building on experience gained through other packages. The main purpose of each work package is detailed below:

Work Package 1: Project Management (continuous)

The first work package was focused on ensuring that the project was properly managed, and ran concurrently with all other work packages.

Work Package 2: Baseline Review (Jan 2012 – Jul 2012)

The first main tranche of work was the baseline review of current practice, exploring how assessment practice, employability and technology use were currently intertwined at the University.

Work Package 3: Clarifying challenges and specifying areas for change (Jan 2012 – Aug 2012)

Running in parallel with the baselining, modules would be identified which were good candidates for change, i.e. those where existing assessment practice could be adapted to be more ‘authentic’ or employability focused, using digital technologies in order to support this.

Work Package 4: Plan assessment practices and processes (Mar 2012 – Nov 2012)

The fourth work package was concerned with planning new assessments from the identified modules in work package 3.

Work Package 5: Implementation of new assessments and embedding into the curriculum (May 2012 – Aug 2014)

The largest and most challenging work package, work package 5, was the core of the Collaborate project, engaging directly with academic staff, students and employers. It served a dual purpose, both seeing that new assessment practices were successfully implemented, and also working to ensure that whatever changes made were embedded.

Work Package 6: Evaluate overall impact of interventions (Dec 2013 – Aug 2014)

Several methods for evaluating the success of any interventions were planned, these are detailed in full in the ‘Outcomes and Analysis’ section of this chapter.

Work Package 7: Embed innovations and plan for sustainability (Aug 2012 – Aug 2014)

Sustainability was planned into the project in order to ensure that any successful interventions continued, and that tools and techniques were taken up further.

Work Package 8: Communication of outcomes (Oct 2012 – Aug 2014)

A wide range of regular communications was planned, from simple blog posts to presentations and papers at national conferences.

Participants

Collins et al (2004) have suggested that carrying out design research requires “much more effort than any one human can carry out” (Collins et al, 2004, p. 33). It was fortunate, therefore, that as manager of the Collaborate project I was able to call upon not only the wider project team, but also an extensive network of stakeholders as part of Collaborate. The Collaborate project was intentionally designed to engage with a wide variety of stakeholders from its beginning which ensured, as before at School A, that goals and design constraints were “drawn from the local context as well as the researcher's agenda” (Design-Based Research Collective, 2003, p. 6). This engagement is depicted graphically in Figure 7.2, using a star format which places the design of new assessments at its centre. The star also highlights the contrast between the intention set at its heart, which is driven by the assessment, and the invariants located in the digital technologies at the stars periphery. It clarifies the core role that assessment and hence intention plays, together with the myriad of *potential* technologies that might be aligned, and the implicit challenge of connecting these two through affordance.

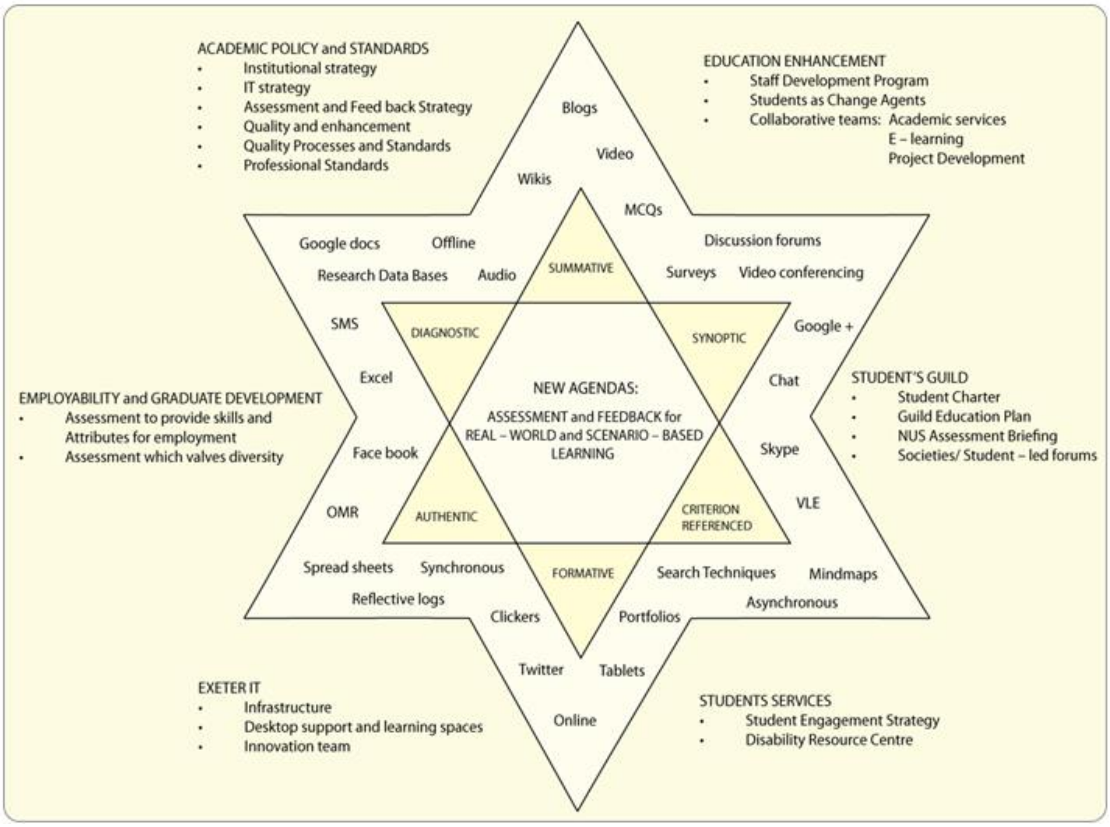


Figure 7.2: Cross institutional collaboration for designing real-world and scenario based activities (from the Collaborate project plan)

Staff and students are not depicted as separate units in this diagram; rather they are implicitly at the heart of the star. The new forms of assessment that the project aimed to create lie at the heart of the star, are hence these are intrinsically linked to the staff and students who would design and undertake these assessments.

In addition to staff and students, five of the University's central professional services, along with the Students' Guild, were engaged to support changes to assessment and feedback practice, as outlined by the outer ring of Figure 7.2. This ensured that areas of expertise from each division were captured, and that connections were made between disciplines which would otherwise remain hidden. As Chapter 3 has discussed, the relational nature of affordances means that individuals tend to see different affordances depending on their personal context, so having multiple viewpoints should help to highlight multiple potential affordances.

Working inwards, the next layer of the diagram indicates a variety of potential technologies that might be used by staff and students during the course of the project, and consequently the potential invariants that might be explored. Finally the inner layer of Figure 7.2 indicates six forms of assessment that were deemed to have potential: summative and formative assessment, but also synoptic, diagnostic, criterion referenced and authentic assessment. Authentic assessment in particular was seen as potentially critical in supporting the aims of the wider project.

Finding suitable participants

As with research at School A, a technique of purposeful selection was adopted (Maxwell, 2005; Bryman, 2012) in order to “select individuals ... according to their (expected) level of new insights for the developing theory.” (Flick, 2006, p. 126). This was done by searching the database of modules available at Exeter using keywords relevant to the wider context of the research. The purpose of these searches was to find participants who were already working in ways which blended the three key aims of the project, those of employability, assessment and technology. This should provide a focus on pedagogical intention which might then be captured.

All modules at the University of Exeter follow a standard module descriptor pattern, an example template for which is included in Appendix E2, which ensures a consistent approach to module delivery across the institution. This also gives a rich set of data about current modules across the institution, which it is possible to mine using database queries in order to form a broad overview of activity with regards to the three threads of the project of technology, assessment and employability. Using these three threads would provide the focused intention of the academics involved, the first part of the design framework, which in turn should lead to detection and use of relevant affordances from the students taking those modules.

A set of module descriptor searches was designed, which used specific keywords for the three key areas of employability, technology and assessment. Parts of the module descriptors were then selected to be searched for each set of keywords, and searches were run to discover which modules matched which keywords in which area. This targeting of specific areas to match ensured that a valid but manageable level of data was returned. Pattern matching was used in all cases, with a 'wildcard' on each side, so the word 'employer' for example also matched words such as 'employers'. This match of key area of context, keywords, and module descriptor fields can be seen graphically in Table 7.1.

Area of Context	**Keywords**[2]	**Module Descriptor Fields searched**
Employability	employability, employer, employment, job, career, workplace, real world	Modules aims, Personal and key transferable / employment skills and knowledge, Assessment
Technology	audience response pad, blog, clicker, computer, concept map, database, discussion forum, e-learning, e-portfolio, elearning, electronic vot, eportfolio, geo, information and communication technology, information and communication technology, information technology, instant messag, internet, mind map, mindmap, online, podcast, reflective log, search engine, simulat, sms, social network, software, spreadsheet, survey tool, technology, technology enhanced learning, text messag, touch tech, video, virtual, wiki	Modules aims, Learning activities and teaching methods, Assessment
Assessment	formative, summative, synoptic, synopsis, criterion referenced, criteria referenced, diagnostic, authentic, scenario, simulation	Learning activities and teaching methods, Assessment

Table 7.1: Keywords used in module database searches

Keywords were derived from the existing project plans, and in particular the 'star'

[2] Some terms have been deliberately truncated in order to achieve a better match.'The use of 'electronic vot', for example, would not only match 'electronic voting' in this case but also variants such as 'electronic vote'

diagram that summarised the overall approach, as shown in Figure 7.2, moderated through research team discussions and previous experience.

This database searching technique had several potential weaknesses:

1. Use of too few or incorrect keywords, therefore not returning a full picture of current practice
2. Use of too many keywords, returning too many results for meaningful analysis
3. Inaccuracy of module descriptors, rendering results irrelevant

In order to mitigate points 1 and 2, multiple test searches were carried out with two distinct data sets (the Business School and the Graduate School of Education) where I had prior knowledge of the type of matches that the process should return, in order to hone the keywords used and the fields against which they were being matched. Results from these test searches were then matched with known samples of modules which had already been selected for inclusion, using this method it was possible to reduce the number of false positives and true negatives, and improve the sensitivity of the research instrument.

In order to mitigate against the third point, that the data itself may have little relevance to actual practice, advice was sought from key individuals involved in programme accreditation and module management as to the relevancy of the data contained. Initial results suggested that the data was sufficiently up to date, though might not fully reflect all practices. It was considered sufficiently detailed and accurate for the current research purposes.

Running these queries on the data returned a total of 449 possible modules (from a potential pool of approximately 2,300 modules in active use at Exeter) that might be a suitable match for the research. These 449 modules were then individually examined in order to rule out false positives, and to manually identify modules which appeared to be best suited using human rather than machine intelligence. This process resulted in a final pool of 81 modules which were deemed most suitable for inclusion.

Discussions with the lead academics on these 81 modules took place, and 17 of these individuals were keen to explore how they could make changes to their assessments. The names, levels and disciplines of these 17 modules are listed in Table 7.2, below:

Code	**Module Name**	**Level**	**Discipline**
BEM2007	Operations Management	2	Management
BEM3009	Ethics and Organisations	3	Leadership
BEE3016	Investment Analysis and Portfolio Management	3	Economics
BEM3009	Ethics and Organisations	3	Business
BIO3082	Science and communication	3	Biosciences
CSC2001	Integrated Clinical Science 2	2	Medicine
CSM3332	Feasibility Study	3	Mining
DRA3012	Applied Drama	3	Drama
ECMM101	Industrial Case Studies	M	Engineering
GEOM150	Social Enterprise, Environment and Sustainability I	M	Geography
MLS3027	Commercial Spanish	3	Spanish
MLS2032	Commercial Spanish	2	Spanish
POL3186B	Gender, Militarization and Resistance	3	Politics
POLM060	Global Security	M	Politics
PSY1301	Professional Issues and Development	1	Psychology
SSI1001	Learning from Work Experience	1	Social Sciences
N/A	Virtual Law Firms (all of Law)	1	Law

Table 7.2: Potential modules for intervention

These 17 modules provided a updated research design, which has already been introduced in Chapter 5, but is reproduced here for clarity as Figure 7.3.

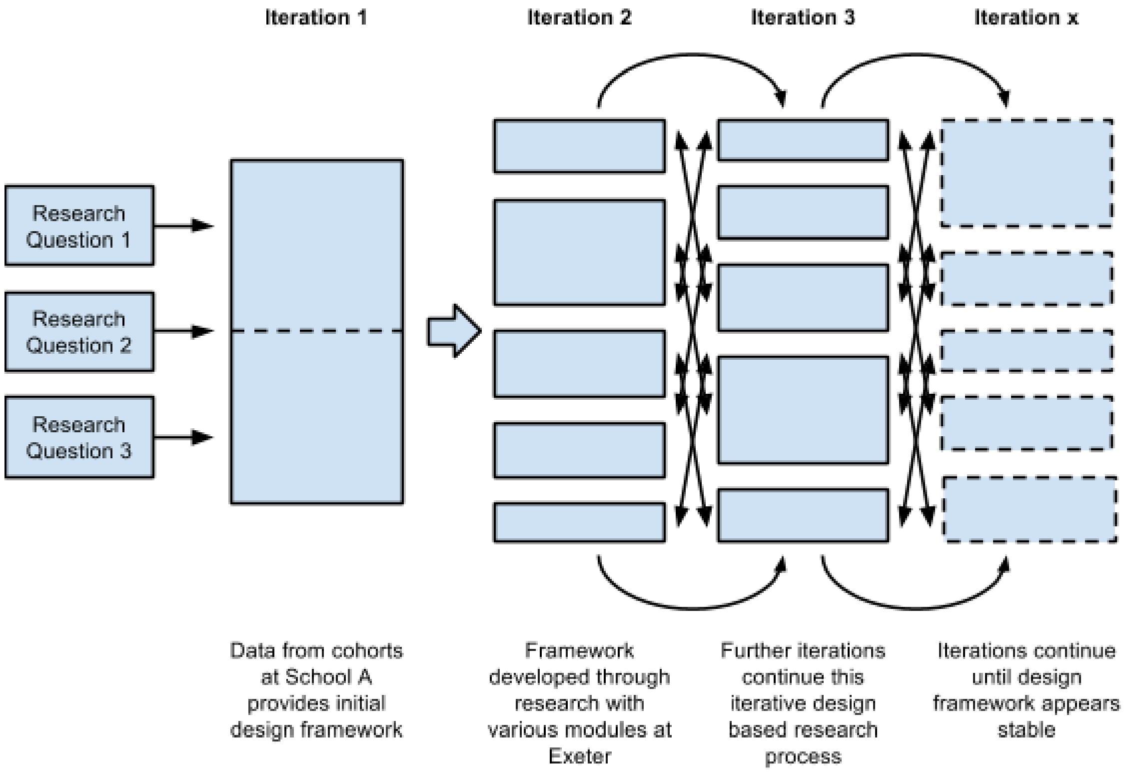


Figure 7.3: Updated research design (University of Exeter)

The framework depicts how research outcomes from work at School A fed directly into new iterations at Exeter. It also depicts, using the size of boxes, how different types of modules were involved in the research, and how the analysis of separate modules fed into and across work on other modules. As Collins et al (2004) comment, design-based research was originally conceived as a way of understanding the richer and more complex environment around a learning situation, as opposed to controlling independent variables, and Brown and Campione (1996) stress that it is in the systematic analysis of the interdependence of the elements of a design that the power of the methodology becomes apparent. By choosing many modules to study, both simultaneously and iteratively, the rich interdependence between intention, invariant and affordance should become apparent.

Detailed outcomes and analysis of interventions with key modules from this process are described in the Outcomes and Analysis section of this chapter.

Real environment

The location for the research was the University of Exeter, based in Exeter, UK. The University of Exeter is known as a campus University, as opposed to a city University, as it is based within its own grounds outside of the city centre, in buildings purpose built for teaching and learning.

The bulk of the research was carried out in traditional style lecture and seminar rooms. One notable exception was the use of a room officially known as ‘Exploration Lab 2’, but more commonly referred to as the surface tables room, which contains 10 multi-touch interactive computer tables (Figure 7.4). This room played a key role in some evaluation work, which is detailed in full in the ‘Outcomes and Analysis’ section of this chapter.

Figure 7.4: Multi-touch interactive computer tables

Digital environment

Research at School A focused on one piece of digital technology, Adobe Visual Communicator, a complex but relatively easy to use software that was specially selected for the context. It was also an expensive piece of software that I was able to procure for School A through a professional relationship at no cost. Very early it became clear that the work at Exeter would not suit use of this software: practically speaking it would be too complex to install for all the potential modules where intervention was planned, and economically it would simply be too expensive.

The research at School A had suggested, however, that the underlying value of the digital technology in that case had been its 'interpretive flexibility'. The Adobe Visual Communicator software did not determine precisely what could be done with it, it provided a digital place that could be interpreted according to need, and hence offer multiple affordances according to intention. What was necessary therefore to continue the research was not the same software, but software which offered similar levels of interpretive flexibility.

The star diagram shown in Figure 7.2 includes multiple types of digital technologies, but is particularly focused on mature digital services which might be considered as interpretively flexibility. Wikis, for example, as a group may have common functions but are open to many different use cases, e.g. glossaries, portfolios, personal diaries, etc. Similarly Blogs might be used as reflective journals, as public records, as minutes for team meetings, etc. The star diagram intentionally includes only a very few mentions of computer hardware, it attempts to be 'hardware agnostic'. Chapter 4 has outlined how hardware can be seen as the portal through which a digital place is accessed and used. It may control *how* that place can be accessed, and potentially impact the types of interaction that are possible within that place, but it does not *change* the place itself.

Only tablets and clickers (electronic voting systems) were initially included as hardware. Tablets were added to the mix because of their emerging popularity at the time of planning, and clickers were included because of their unique form factor, blending as they do hardware and software into a technologically determinist form, but one with a specific pedagogical use. This list of technologies therefore provided an initial pool to explore the invariant end of the affordances trinity.

Intervention design and implementation

This section describes how specific tools and techniques were researched and developed to create the elements of the design framework, in order to align pedagogy and technology.

Developing the design framework

The research at School A as outlined in Chapter 6 proposed an initial design framework, based on the affordances trinity as described in Chapter 3. Edelson (2002) suggests that a design framework can be thought of as “a collection of coherent design guidelines for a particular class of design challenge.” (Edelson, 2002, p. 114). It is a prescriptive framework that defines how, given a specific context and challenge, particular goals might be met. Instead of independent design principles that could be used in isolation, a design framework might also be considered as part of an ‘ecological approach’, where design principles relate both to each other and to the context in which they are used. Figure 6.22 in Chapter 6 attempted to visualise this ecological relationship, depicting the ‘relationship of the individual with their environment’ (Merriam Webster), through affordance, and providing a theoretical basis for the development of the framework. The purpose of the research at Exeter from the perspective of the current research was to develop and test this concept of a design framework further, and to tease out the underlying relationship between intention, invariant and the transactional ‘space of possibilities’ of affordance.

This framework is realised in the form of practical artefacts. As Kelly (2004) notes (quoting Simon, 1969), “design is not design without some form of designed artefact” (Kelly, 2004, p. 116). Kelly argues that this artefact need not be a concrete artefact, that it may in fact be a record of processes and procedures, but nonetheless the creation of something practical is at the heart of a design-based research approach:

> “... design studies should produce an artefact that outlasts the study and can be adopted, adapted, and used by others.”
>
> Kelly (2004, p. 116)

The affordances trinity, and resulting initial design framework, was used as a basis for design decisions at Exeter. Three design phases were extrapolated from the initial design framework, which shaped the way design research at Exeter was planned and implemented. The way in which these phases were embedded into the Collaborate project is outlined in table 7.3:

Design phase	**Research purpose**	**Place within wider project**
Phase 1: Capturing pedagogical intention	Define the specific pedagogic context, use it to capture the intention of the learners	Aligned with the ‘Baseline Review’ and the ‘Clarifying challenges and specifying areas for change’ work packages
Phase 2: Identifying invariance of digital places	Choose interpretively flexibility technology, ensuring a broad range of potential invariants	Aligned with the ‘Plan assessment practices and processes’ work package
Phase 3: Aligning intention and invariant through affordances	Identity transactional ‘space of possibilities’ of affordance that links intention and invariant	Aligned with the ‘Implementation of new assessments and embedding into the curriculum’ work package

Table 7.3: Design phases of research at Exeter

Although these phases are presented chronologically, this is for ease of understanding rather than to represent reality. In practice they tended to run concurrently and largely overlapped. Phases tended to inform each other constantly, but did so in two distinct types of iteration, which might be termed micro and macro iterations.

Micro/macro iterations

Design-based research is an iterative approach, where cycles of design, evaluation and re-design are used to hone principles and products in order to produce robust and grounded outputs (Wang and Hannafin, 2005). It is, perhaps, not always clear though precisely *what* it is that is being iterated.

Previous work at School A had planned to iterate from term to term, using whole blocks of research to inform later work, a type of macro iteration designed to produce similar macro changes in the design process. In practice much of the research at School A actually revolved around micro iterations between and even within individual sessions, as technology issues were addressed, teaching guidance was updated, and student confidence grew.

This type of micro iteration within a broader macro iteration has been recognised by Gravemeijer and Cobb (2006), and a model for the research at Exeter was created based on their notion. This is represented graphically below in Figure 7.5:

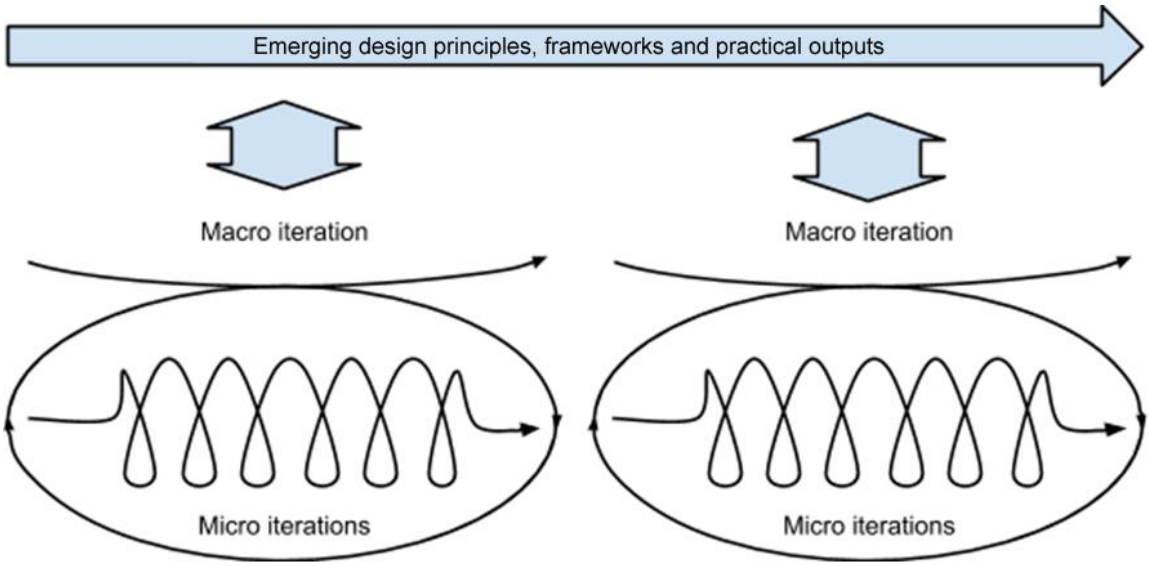


Figure 7.5: Macro and micro iteration cycles
(based on a model by Gravemeijer and Cobb, 2006, p.29)

This type of macro iteration, based upon and as a product of micro iterations, seems to better reflect the actual design process, which tends to be - as has already been noted - a messy business (Mor, 2011). Much conversation and debate takes place, informed by data gathered during the research process, but this often appears to have very little effect until suddenly a significant jump forward takes place. In practice this can be tied down to an extensive period of micro iteration that is not always visible. The design narrative approach taken here is designed to expose the micro iterations as well as the macro iterations, allowing others to follow the design process and see not only what worked, but also what didn't work in practice. As Hoadley (2002) put is, the narrative can:

> "… help make explicit some of the implicit knowledge the designer or designer-researcher used to understand and implement the intervention."
>
> Hoadley (2002, p.2)

The narrative continues in three sections, covering the three phases as outlined, beginning with research to capture pedagogical intention.

Phase 1: Capturing pedagogical intention

Theoretical explorations of affordance and research at School A had suggested that intention is a key driver for the detection and use of affordances, therefore identifying and defining intention clearly was a key part of the design framework. This first phase of the research intended to tease out what elements might comprise the specific educational context of the wider project, that of developing students employability through assessment, as by doing so the intention of learners should also be captured. This then in turn should allow digital technologies to be aligned with this intention.

Two methods were combined in order to capture pedagogical intention, further limited literature review into authentic assessment and interviews with key participants.

Revisiting literature: authentic assessment

Authentic assessment had already been listed as a potential area of focus. It was decided to complete some further limited literature review in this area, in order to tease out the key elements of the concept of authentic assessment, and how they might relate to the data gathered through interviews with key participants. Figure 5.3 (The “DBR Spring” model aligning process steps over time) has illustrated how literature review can stretch out into iterations, so this was seen as a valid step from a design-based research perspective.

Assessment is widely acknowledged as a key driver of student behaviour. As Gibbs (2004) summarises, what students attend to, how much work they do and how they go about their studying is dominated by the way they perceive the demands of the assessment. Assessment is potentially therefore a valuable mechanism through which the intention of learners could be captured and focused, providing the overall context within which to align digital technologies. If, as Gibbs suggests, assessment drives behaviour, then it should also focus intention - a key aspect of the affordances trinity.

The term authentic assessment can trace its origins to the US K-12 system in the early 1990's (Terwilliger, 1997), and was originally a reaction against the use of multiple choice questions as the core or only way of assessing students' performance. The use of the word authentic has proved challenging, however, as Terwilliger summarises:

> "… the term inappropriately implies that some assessment approaches are superior to others because they employ tasks that are more 'genuine' or 'real'."
>
> Terwilliger (1997, p.27).

Although authentic assessment "appears to be increasingly used in further and higher education" the term is still not widely understood (Falchikov, 2005), partly perhaps due to multiple perspectives and definitions (e.g. Wiggins, 1993; Gulikers, Bastiaens and Kirschner, 2004; Mueller, 2005). Indeed, surveys by Whitelock and Cross (2011) at the Open University suggest that only 25% of the academics surveyed had heard of the terms 'authentic learning' and 'authentic assessment'.

In order to bring more clarity to this area Whitelock and Cross (2011) analysed literature from key writers in the field, and based on this analysis summarised the common features of an authentic assessment, which included:

- Collaboration that is similar to that experienced by practitioners or experts in the field
- Simulations of role-play or scenarios
- Problem tasks that are like those encountered by practitioners or experts in the field
- Resources taken specifically from real-world case studies or research
- Tasks that students find meaningful
- A range of assessment tasks rather than just the "traditional" ones

Herrington (2006) has also explored the area of authentic assessment, and produced a list of ten characteristics from the literature to summarise the notion of ‘authentic tasks’:

1. Authentic tasks have real-world relevance
2. Authentic tasks are ill-defined, requiring students to define the tasks and sub-tasks needed to complete the activity
3. Authentic tasks comprise complex tasks to be investigated by students over a sustained period of time
4. Authentic tasks provide the opportunity for students to examine the task from different perspectives, using a variety of resources
5. Authentic tasks provide the opportunity to collaborate
6. Authentic tasks provide the opportunity to reflect
7. Authentic tasks can be integrated and applied across different subject areas and lead beyond domain specific outcomes
8. Authentic tasks are seamlessly integrated with assessment
9. Authentic tasks create polished products valuable in their own right rather than as preparation for something else
10. Authentic tasks allow competing solutions and diversity of outcome

Herrington (2006, p. 3167)

To be 'authentic' it seems means to recreate the challenges of real world places, and the intention and invariance of those real world places, but in order to do this from an educational perspective this 'real world' needs to be simulated. There is therefore a natural alignment between the principles of authentic assessment as the base for capturing pedagogical intention, and the notion of digital technologies as places in their own right.

These conceptions of authentic assessment from existing literature provided a starting point, and were combined with interviews with key participants in order to develop themes capturing pedagogical intention.

Research instrument: interviews with key participants

The purpose of the participant interviews was to further clarify the context within which the research was operating, to summarise the thinking of participants with regards to the three key wider threads of assessment, employability and technology. By capturing the context through interviews with key participants, it should in turn be possible to capture the pedagogical intention of teachers and learners, and hence identify relevant potential affordances. Note that this thesis only discusses issues with employability when they are particularly relevant to the research itself. Much work was undertaken as part of the wider Collaborate project that is not relevant to the present research, and hence it is not discussed here.

Consultation with practitioners is a key aspect of design-based research. As others have noted (McKenney et al 2006; Herrington, 2011) it is unusual in traditional research for practitioners to be integrated into early stages of research, but as Herrington qualifies:

> "Consultation with practitioners who are familiar with the problem area of the research can provide rich insights into complexities inherent in a significant educational problem, because these insights are based upon their intimate and practical understanding of the issues."

Herrington (2011, p. 597)

Herrington goes on to suggest various ways in which this consultation may take place, including the use of interviews to deliberately target individuals who have the potential to make a valuable contribution based on their practices. This was the method chosen for the present research, semi-structured interviews with key individuals familiar with the problem area of the research. The semi-structured interview was chosen as it allowed some flexibility in approach, not only with the order of questions as asked but also with the ability to add extra questions in order to pursue particularly interesting lines of inquiry (Bryman, 2012).

The interviews consisted of four blocks of questions designed to make explicit their knowledge, with regards to employability, technology and assessment. The four blocks were not all designed to be delivered to every stakeholder group. Although the groups would certainly have common experiences between them, they will in turn also have their own specific insights to bring on the issues raised, so one block of generic questions for all interviewees was designed, and then three different blocks of questions were designed, tailored to be delivered to either students, staff or employers. In addition to notes taken by the interviewers during the interviews, the videos were all filmed, and then analysed later for particular insights. The full set of interview questions and guidance can be seen in Appendix E3, and the consent form for the interview and subsequent use of video in Appendix E1.

Selecting interviewees

Academic colleagues who had been identified through the module database searches as already engaged in authentic type practices were invited to be interviewed, in order to isolate and document their implicit knowledge of good practice. Student participants were proposed by some of these academics, whilst some random sampling was also undertaken with students within Colleges. Other potential interviewees were selected from key internal stakeholders as listed in Figure 7.2, the star diagram. Specific interviewees were largely identified through existing connections, with internal structures and hierarchies providing key individuals who manage specific areas, and these individuals in turn nominating other individuals from their teams to be included. This approach simplified the process of connecting with key individuals, and provided a wide range of individuals at different levels of the institution.

A total of 40 individuals were formally interviewed to discuss their interpretation, a broad breakdown of these 40 interviewees is shown in Table 7.4.

Stakeholder group	**No of Interviews**
Academic Perspectives	10
Employers and Employability	11
Technology and Administration	6
Students	18

Table 7.4: Breakdown of interviewees by stakeholder group

Data analysis: interviews with key stakeholders

Interviewees were analysed using two techniques - handwritten memos during the interviews, and post-interview analysis of the video data gathered.

As in the work at School A, I preferred to use a tablet computer to write notes using digital ink, so although notes were handwritten, they were stored in computer form. They were also stored using ‘cloud’ technology, i.e. they did not reside on the hard drive of the device used, but instead were based on networked computers linked through the Internet. This ensured that notes were always on hand through whichever device I happened to be using, a level of flexibility which proved valuable on countless occasions.

It is perhaps interesting to reflect on how the manner in which digital technologies can provide a different experience of time and space in this way can aid in the research process. Just as Chapter 6 has tentatively explored the concept of chronotopes and their value in learning, so perhaps the different manner in which digital notes could be experienced had an impact on the research. The ability to bring into conversations and discussions relevant interview notes at the point in time at which they could be most valuable is perhaps not as trivial an issue as it might at first appear. From a personal perspective it enabled richer and more productive discussions. Anecdotally at least, more decisions on new ways of proceeding in the research seemed to be made, as more data could be brought to bear on questions raised as these occurred. Arguably non-digital forms can help in the same manner, but they differ because they are limited by their own space/time. In a real notebook, for example, it is physically necessary to move through pages to get from one point to another point. In the digital equivalent, travel is directly possible between disparate points in the notebook, there is no need to traverse a mid-point in order to arrive at your digital destination. This may be a small distinction, but it is a real qualitative difference between the real environment and the digital environment. The issues will be returned to in Chapter 9, alongside discussions of the notion of the chronotope.

Samples of the videos which stood out as being particularly relevant to the three wider threads of either employability, assessment or technology were assigned codes that summarised their key content, and added to a ‘video wall’ blog, ‘Collaborate Voices’, an early image of which can be seen in Figure 7.6.

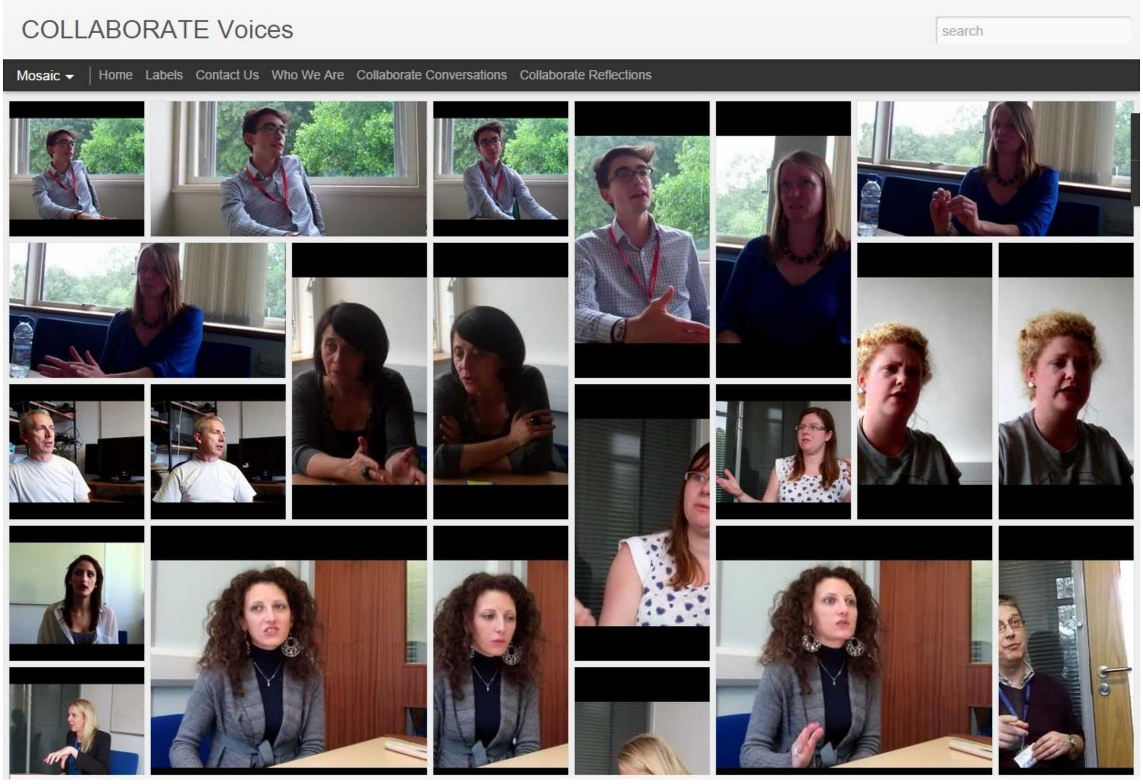


Figure 7.6: The 'Collaborate Voices' website, showcasing key thinking from stakeholder interviews

These broad codes were compared with written notes taken at the time, and six reports were written summarising key themes as they emerged from these interviews, which were published for each College in turn as interviews progressed. These have been further summarised into the core themes describing context, below.

Themes emerging from interviews with key participants

As during the research at School A, a thematic analysis was carried out to pick out the core themes from interviews with key participants. These themes are presented below, supported by the direct quotes from interviewees as appropriate.

Value of authentic assessment

It became clear that the forms of assessment listed at the heart of the star in figure 7.2, i.e. the six forms of summative, formative, criterion referenced, diagnostic, synoptic and authentic, were not well known within the sample. The vast majority of interviewees had only heard of formative and summative assessment. Although formative assessment seemed more widely recognised than it perhaps had been anticipated, even that was still at an early stage of adoption. Only a few very senior academics, or leading academic development professionals, seemed familiar with other forms of assessment, and of those the only forms of assessment actually being used in practice on top of formative and summative were diagnostic, authentic and a sole instance of synoptic.

> “I could answer yes to the first two, after that I glazed over ... I haven’t heard of them, let alone know what they are”
>
> Senior Academic

Of the six forms of assessment that were mentioned in interviews, it is interesting to note that the word ‘authentic’ had a natural synergy with the wider aims of the project. Even if interviewees were not familiar with the term, they felt it was something that they could easily see the benefit of and that the term was not too specialist or technical. Some interviewees reflected that authentic assessment seemed to have natural affinity with the workplace, in contrast to the summative exams which form the mainstay of University assessment practice.

> “You don’t ever have exams in the real world unless you’re studying for a professional qualification”
>
> College Employability Officer

Assessment distributed over time

This theme summarises the contrast between what might count as assessment in professional contexts with that in educational contexts. It was observed that ‘assessment’ in business, or what might be better termed evaluation, was an ongoing process, often informal, rather than a single fixed point of measurement. Assessment in business is much more about ongoing, formative feedback, from clients as well as peers. Although there is some formal summative assessment, for example exams required by professional bodies, this comprises only a small amount of the overall evaluative practice within business. Any one individual will be managing various problems with various points of evaluation or assessment along the way, so the ability to manage a distributed set of assessments over time is crucial.

> "Something that really gets people to show that they can perhaps prioritise and manage their workload and their time, because ... I think that that's something that actually whatever job role you go into you have to be able to do."
>
> Employability Officer

University assessment systems seem to focus more and more on summative forms as students' progress closer to employment - raising the intriguing notion, do they approach assessment the wrong way round? Should they actually be focusing on forms of assessment that are closer to those found in employment, i.e. formative and authentic, as students get nearer and nearer to the beginning of their professional careers. Current assessment practices seem to be aimed at producing an overall mark that summarises how well a student has performed over the past 3 or 4 years, a single benchmark that it seems is increasingly meaningless to employers looking for attributes which will allow them to distinguish individuals from the crowd.

Students were in agreement that a varied approach in the type of assessments, and having assessments spread across the module, was far more beneficial to them and their learning than simply having an exam or essay at the end, something which our literature review has correlated, with one student noting that their entire degree had been a process of "churning out essays".

A way of making assessments more authentic may be to increase the time pressures on students. Speed of work is an important dimension in employment, and many employers see more value in an acceptable piece of work that is delivered quickly, as opposed to a very good piece of work that takes much longer to create.

> "Most employers not so interested in perfection, more the speed. How fast can you achieve a certain level."
>
> Senior Academic, Physics

Moving away from a single large piece of assessment at the end of a module to a staggered set of assessments naturally increases time pressures on each assessment as there is less time available for each. A more distributed pattern of assessment is inherently therefore more authentic. This theme suggested that in order to capture the specific pedagogic intention being explored it would be necessary to include some way of ensuring assessment is distributed in time.

Varied audiences

A recurring thread through the interviews was the importance of articulation and of evidence, of responding well to varied audiences.

> "Sometimes I think the students have actually got a lot more of the skills than they realise they have, I think a lot of the time the students have gained the skills they need ... but they're not very good at articulating them to employers"
>
> College Employability Officer

Students often gain various skills through their studies, but at the same time they are not conscious of the level at which these skills have been developed within them. Assessments which make them reflect on their skills, and use scenarios whereby they have to communicate how they have come to know what they know, as opposed to what they know, give students critical articulation skills which they later find are incredibly relevant in employment interviews.

> "I will often meet students with good research skills ... but they don't seem to be able to apply those skills that they've got, that you know they got, to a different situation ... because it looks or feel so different ... some students really seem to struggle with that."

College Employability Officer

Coupled with this need for articulation is the importance of evidence. Employers are often looking for team-working or project management skills, but in order for the student to be able to demonstrate this they must have evidence that they have worked in ways which have developed these skills. Simple lines on an application form which talk about attending courses, or show an appreciation of the key aspects of these skills, are not enough.

> "Especially in maths we are always working towards 'how can we do well in the exam', whereas in this project it was 'how can we show what we have done' and the assessments were used for that reason rather than just saying 'ah look this is how much I know'"

Mathematics student

Spending effort trying to ensure that students have the skills they need in business or life more generally is irrelevant if they cannot articulate what they have learnt well. Students often do have much more skill than they are aware of, but lack the ability to articulate this to third parties and hence can either fail to find work or do not deliver in work as much as they could.

Capturing pedagogical intention for this theme would entail embedding within the assessment methods to expose the students to new and challenging audiences, and encouraging them to articulate their experiences to those audiences.

'Real world' problem / data

The importance of using real world data or problems was highlighted by multiple academic interviewees.

> "We specifically try and use actual data sets, ermm, we anonymise them, obviously, and I may set them in another world, but it's exactly the same type of thing students will be working on."
>
> Academic, Mining

> "In terms of real world / problem data all the projects have to be grounded in this and they have to be data rich in the sense of either collecting your own data or analysing someone else's data ... we also have other projects looking at statistical data - what is the average winter temperature across Europe and what factors affect that, and so there they are looking for correlations in data that someone else has collected. So they are very definitely data rich problems from the real world."
>
> Academic, Mathematics

Students also reflected on how the use of real world data seemed more meaningful and motivating for them.

> "They took us out to Stoke woods, and got us to kind of measure trees and these kind of things, and then just said here is this spreadsheet of data, I want you to do your reading, come up with a question, and answer your own question with this set of data ... the real world stuff is so much more interesting."
>
> Geography student

Using real world data and problems in assessments brings in the types of work that students will be encountering in the workplace, and hence is much more ‘authentic’ in terms of working in a business environment outside of higher education. This becomes increasingly important in disciplines which are very non-vocational, where the focus may well be more on essays and exams as assessment types, and so students rarely encounter other ways of demonstrating their knowledge before they finish their degrees.

> “In my workplace and probably most workplaces, it’s about practical application and not so much the theory... it’s difficult to talk about how you can make research more practical, because a lot of what you’re doing at university by its very nature, is learning about the theory...”
>
> Employer, Law

> “Take an example, say you know flood modelling, or flood prevention systems, something where you could say, this is your assignment, but this is something that would be given to you say you were going to go into this industry.”
>
> Geography student

Similar thoughts were echoed from other internal stakeholders:

> “... when they do get in and undertake the work, it’s very rare that they will be undertaking elements like essay writing and have to develop a new range of skills ...”
>
> Careers Consultant

To capture this particular pedagogical intention, therefore, elements of real world data and real world problems should be embedded into the assessment in order to develop students’ skills in working with this type of data or problem, analysing it, evaluating it and discussing it.

Collaborative working

Various aspects of working together as a group were reflected upon by many interviewees, which have been summarised in this theme under the title ‘collaborative working’, as this was seen to be an important aspect to working life beyond University.

Sometimes this work tended to be more cooperative than truly collaborative, with group working adding up to little more than simply sharing different parts of work together in order to try and form a coherent whole.

> “In other modules you sort of ... OK, I’m gonna do this section you do that section ... and you don’t actually collaborate, you literally just put bits of what you’ve done together, whereas for this module you had to meet up and you had to discuss what you were going to do because you were making your own structure”
>
> Geography student

In other cases, students actively selected participants who they thought would be most likely to help them achieve the best mark possible in the assessment.

> “I don’t choose the groups, they choose themselves, and sometimes they choose people that they think they can work with rather than their friends, because they believe that the people that they are choosing are going to help them deliver the project.”
>
> Academic, Modern Languages

Colouring both these scenarios was the recognition that the team that you would be working with would not always be your own choice, and could contain its own challenges in terms of working relationships.

> "... you have to be able to work in teams ... but there is a difference between being a team player and being able to work in teams...I think it is a bit of a cliché when people say 'team player', obviously you have to be able to show that you can work with other people but ultimately, even when you work in a team, you are competing against other people ..."
>
> Academic, Business School

> "it's never plain sailing, there is always going to be something to consider and to consider as a group rather than individual, and work through that."
>
> Academic, Law

This theme suggested that working with others was a core aspect of the overall pedagogical intention, but also suggested that this should include an element of tension, of competition. There was a sense of being required to work with others regardless of your own preferences.

Light structure

An interesting thread that emerged was a distinction between how assessment works in business as oppose to how it works in education. The word assessment is not a word which sits easily in a business context, but nonetheless is an activity that does occur on a regular basis. In the questions for employers the clarifier 'evaluative processes' was purposefully added alongside the use of the word 'assessment', in order to help frame the question in a business context.

What emerged was the notion of business clients as assessors, and the critical notion that in a business scenario you do not know exactly what you will be assessed on. Indeed, it could be said to be part of the assessment itself, in a business context, to work out exactly what is expected from you based on the client and the information that they may or may not be providing. It is part of the overall work to figure out exactly what is expected of you, based on the client or customer.

> "It may well be that, although they won't tell you, their criteria for assessing you might is not anything that you say, but whether you can carry out their instructions."
>
> Employer

This raises the challenging question: is it possible to be too specific in detailing exactly how students get marks from assessments? Should part of the assessment be the task of working out which are the more crucial parts of the assessment itself? It seems that assessment in business is a cumulative and ongoing process with mostly undefined criteria that must be independently discovered, so in order to make assessments more authentic it may be necessary to reduce the level of definition about mark allocation, something which is in direct tension with other research into assessment (e.g. Nicol and Macfarlane-Dick, 2006). There was some evidence from students that such a scenario would not be unwelcome.

> "I think that it is important that ... part of this is that there isn't a set structure to the module and that you are encouraged to set your own goals and targets and with that you really ... that is where the enjoyment came from and we found that if you set your own targets - you know why you are doing them and why you want to do them."
>
> Student, Mathematics

A key aspect of employment is the need to exercise what was characterised as 'professional judgement'. In the workplace situations are constantly presented which require you to decide on the most appropriate course of action, to evaluate or assess what you should do, with little or no ‘scaffolding’ available to you bar previous experience and perhaps peer support. This contrasts with assessment in the University, which is often well structured and framed in such as way as you only need to follow prescribed steps in order to meet the needs of that assessment.

> “You need to be able to say what do I have to achieve today, what is it imperative that I achieve, ermm, what do I have to achieve this week, what is an ongoing project, what do I need to give my focus to.”
>
> Employer

> “I never realised, actually, that I could think for myself, was allowed to think for myself, in University … I thought it was about me listening to everybody else’s views, and this has been a huge turning point for me.”
>
> Business School student

It was noted that something of a change in attitude is necessary, both in academics and students, to move away from a sense of perhaps over-nurturing or ‘mothering’ (a term used by a senior academic) students, to a relationship where they learn to be more self-capable. Employers desire graduates who are capable of at least a certain level of independent action, who can complete tasks even when given incomplete information and incomplete data about that task. Assessments, therefore, which replicate this type of scenario help students to become self-capable through experience.

This theme summarises these concepts under the term ‘Light structure’, suggesting that to capture this particular pedagogical intention it may be important not to be too specific in detailing exactly how students get marks from summative assessments. Part of the assessment is the task of working out which are the more crucial parts of the assessment.

Peer review

Peer assessment or review emerged as a powerful way to include authenticity within existing assessments, as it effectively simulates the type of assessment (or evaluation) that is more commonplace within a work environment.

> "In a computer lab I have all the websites set-up and all the students are given little feedback forms and there's an envelope on every desk, with a name on it, and the students go round and they look at each other's, and they put feedback in the envelope ... what they get out of it, they learn, they see each other's websites, and so they kind of realise that someone has done some fantastic thing that they can then copy and put on their own."

Academic, Biology

It is also a natural accompaniment to group working, something which is already perceived to be a more 'authentic' practice, i.e. the type of practice that is common in employment.

> "In terms of peer and self review, there is quite a lot of that going on. We build these sorts of things into lectures for example, students will bring drafts of chapters along and we will get them to review each other's according to the assessment criteria and give feedback on that. We also get students to rate how well the other members of their team have done and that feeds into the marks that students get for the project. And in the final project report we ask them to evaluate just how well did that project go - what would you have done differently and so elements of review which are a critical part of any project are built into the cycle."

Academic, Mathematics

However, it is not without its challenges. Some interviewees reported incidents where students have been so harsh in their critique of each other that peer assessment has had to be withdrawn. Others highlighted the problem of favouritism.

> “Useful skill to be able to review other people ... tricky to stop it from being a popularity contest.”
>
> Student

> “Students would mark their friends more favourably ... or mark people that they don't know favourably not to upset them ... a lot of things to consider about the quality of the feedback.”
>
> Student

It may also have cultural ramifications according to other reports, whereby individuals from cultures which follow a traditional ‘sage on the stage’ approach to teaching and learning can feel their contributions are not being adequately evaluated, as their peers are not sufficiently qualified to perform this task.

This may be an area where technology could play a valuable part, by not only facilitating peer assessment through the automatic aggregation and calculation of marks, but also by anonymising individual contributions, if felt appropriate. Systems can also be put in place which allow the students and/or academics can have some control over the level at which a peer allocated mark effects an overall mark.

Summary

Analysis of the key participant interviews, and comparisons with the literature describing authentic assessment, have suggested a number of characteristics. These characteristics have been explored above, and were depicted in an early report clustered together, as shown in Figure 7.7 below. Together these characteristics should provide a way of capturing the pedagogical intention of participants, and hence could form one end of a design framework to align pedagogy and technology through affordance.

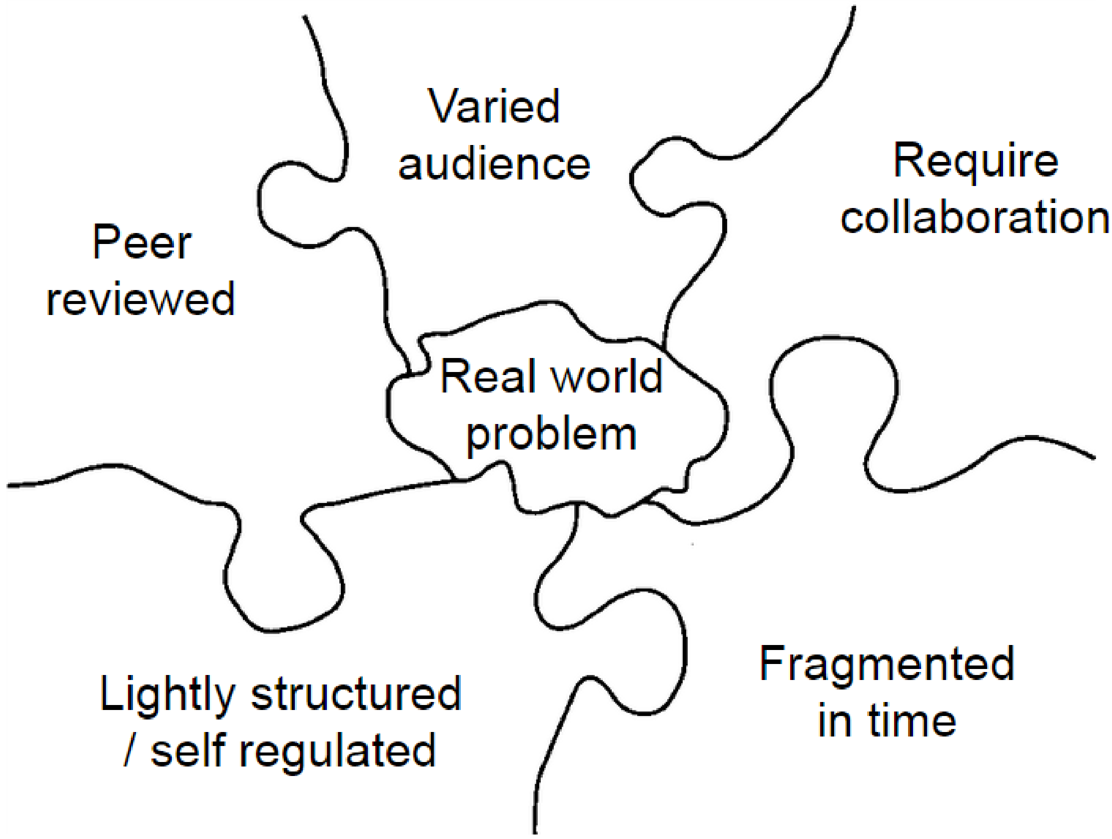


Figure 7.7: Characteristics that emerged from stakeholder interviews and literature review

The characteristics were purposefully illustrated as messy and knitted together at this stage of the research process in order to try and illustrate the complexity of their interdependence. Such a messy and intermingling collection of potential design principles, however, does not lend itself easily to a practical tool to assist in pedagogic design.

Designing a practical model

This section focuses on how the characteristics that emerged from literature review and participant interviews were 'operationalised', i.e. how they were crafted into a practical tool to assist in pedagogic design.

There is an implicit understanding within this research that pedagogy should lead technology. The focus has been on understanding pedagogic intention first, and using that to drive technology choice, not the other way around, and this aligns well with the notion that intention leads to the detection and use of affordances. This concept of putting pedagogy before technology is not new, and the importance of integrating technology and pedagogy has been discussed by others (e.g. Olinzock and Okojie-Boulder, 2006), but whilst the overall *principle* of letting pedagogy drive technology is widely accepted, how this is actually effected in practice is not always clear. Alongside the development of design principles, it has been proposed that design-based research should also attempt to produce practical outputs, “supporting design and development of prototypical products to solve complex authentic context specific problem” (Lai et al, 2009, p. 120). McKenney, Nieveen and Van den Akker (2006) suggest that in a curriculum setting in particular, design-based research should seek to produce three outputs, highlighting curricular outputs as a key product of design-based research.

In order to meet this requirement, to produce a practical output that could be used within practice, a model was intended which would help to prompt thinking around the design of assessments to embed employability into the curriculum, a curricular product which would capture pedagogical intention, which could then be used to align digital technologies using an affordances approach. This model would then act as the method to drive intention in students, and hence form the personal need necessary for the discovery and use of affordances. This development of a model to frame interventions was done using a macro/micro iteration process, with multiple versions produced and each one tested with participants, with feedback and comments informing subsequent designs.

The key challenge from the research perspective was twofold: what should the model actually contain, i.e. what key characteristics did it specify, and what form should the model take, i.e. how were these characteristics related to each other. The previous section has described how initial key characteristics were derived. The narrative continues, exploring the latter issue of the form of the model.

Base model: continuums as design tools

Figure 7.1 within the context section of this chapter depicted five continuums that had initially been planned as a way of framing the research, the continuums of:

- Simplicity/Complexity
- Individual/Community
- Measurement/Learning
- Quality Assurance/Enhancement
- Efficiency/Effectiveness

The initial model for designing assessments began before the key participant interviews, and used these ‘tensions and challenges’ of assessment to create a simple model through which an assessment could be analysed. This model is depicted below in Figure 7.8:

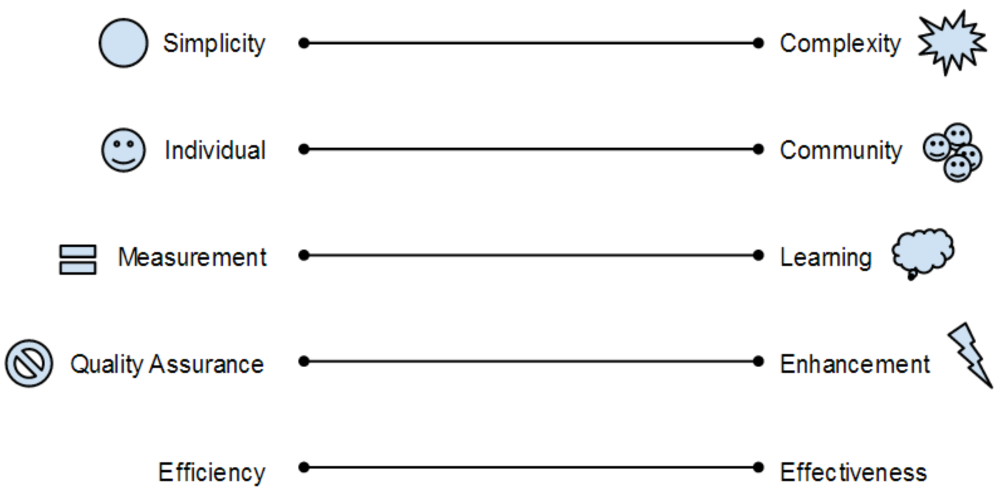


Figure 7.8: Initial idea for a model to capture pedagogical intention

The purpose of placing these continuums opposite each other on horizontal lines was to produce a tool through which individual assessments could be evaluated, marks added to the line to depict where that assessment might lie according to each continuum in turn. An assessment that was entirely individual would be marked on the Individual/Community continuum at the extreme left, for example. How these marks should be placed was initially left entirely to the discretion of the assessor, to see whether the physical boundaries as depicted provided enough of a visual cue for making marks. An example showing this method of 'marking-up' the lines is illustrated graphically in Figure 7.9.

Figure 7.9: Continuums as principles (annotated)

Early attempts using this tool with real assessments rapidly showed its weakness, however, as some of these continuums are not mutually exclusive, therefore making it impossible to place a mark on the line. A single assessment, for example, does not have to be less efficient in order to make it more effective. The language used to define the continuums, the words such as 'complexity', 'effectiveness', etc. are too abstract and cannot easily be understood from the perspective of individual need. If affordances are detected and used according to need (Gibson, 1979), it is perhaps hard to see how a need for complexity can be designed into an assessment, or a need for effectiveness, for example. More critically, the emerging themes from the stakeholder interviews seemed to have no relationship to the continuums as envisaged in theory. An improved model was needed.

Model iteration 2: 'Authentic' continuums as design tools

The analysis of the data emerging from key participant interviews suggested various key characteristics which together might capture pedagogical intention. A new design model was produced based on these characteristics which attempted to blend thinking from the relevant literature on authentic assessment with analysis of the data from the interviews. The new model kept the horizontal lines as a way of contrasting existing practice with new practice, but used the key characteristics as the words to capture each in turn. Single keywords were chosen to describe each characteristic in turn, based on the previous analysis, and are displayed in Table 7.5.

Characteristic	**Origin**	**Traditional assessment**	**Authentic assessment**
Audience	Derived directly from the 'Varied audiences' theme	*Academic*	*Business*
Time	Derived from the 'Assessment distributed over time' theme	*Single, long term*	*Multiple, short term*
Data	Derived from the 'Real world problem' theme (split into two characteristics, as it was envisaged that there might be instances where real world data might be used for a theoretical problem, and vice versa)	*Theoretical, perfect data*	*Real world, messy data*
Problem	Derived from the 'Real world problem' theme (split into two characteristics, as it was envisaged that there might be instances where real world data might be used for a theoretical problem, and vice versa)	*Internally derived, theoretical idea*	*Externally focused. real world task*
People	Derived from the 'Collaborative working' theme, complementing the peer/transfer characteristic but with a greater emphasis on working together as a team	*Individual working*	*Group working / peer review*

Transfer	Derived from the ‘Peer review’ theme, attempted to contrast the didactic lecture form of learning with more collaborative and peer based approaches	*‘Sage on the stage, dialectic learning*	*Peer based dialogic learning*

Table 7.5: Initial characteristics

The ‘Structure’ theme was seen as implicit within the overall form of the model, with the right hand ‘authentic’ side in all cases requiring more self-regulation and less specific direction from academic leads. This proposed model is depicted in Figure 7.10, below:

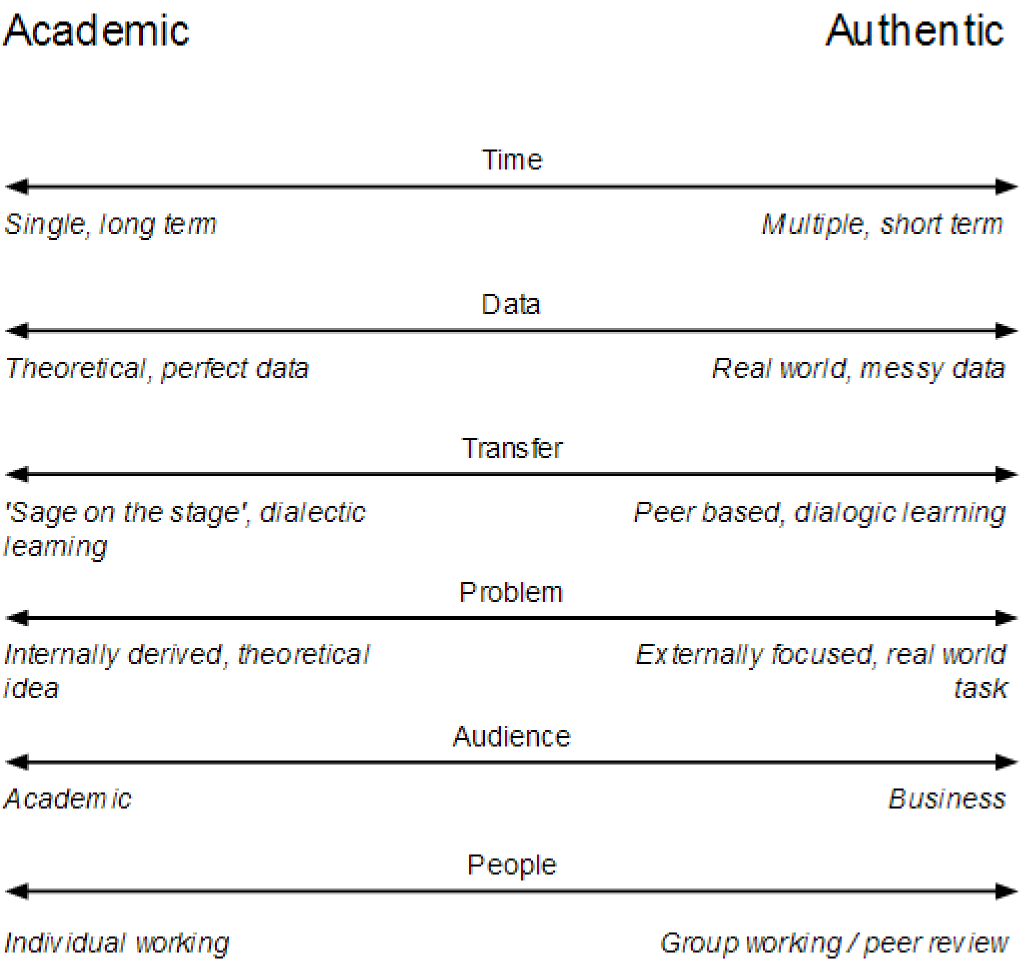


Figure 7.10: Authentic assessment continuums

This model was trialled with participants, and proved to be a useful way of capturing the intention of those designing an authentic assessment, but at the same time it manifested the exact same concerns in the local context that Terwilliger (1997) had previously observed, problems with the use of the term ‘authentic’ in academic contexts. The concerns that were raised centred around the issue that all assessment activity, and for that matter teaching and learning activity, could be considered to be authentic, in as much as they are all authentic in the context in which they are being applied. A more general definition of the term authentic is to describe something that is genuine, therefore using the term ‘authentic assessment’ to describe those assessments which are most suited to the needs of employability runs the risk of suggesting that other assessments which are not authentic are consequently not genuine. This had the potential to have serious consequences for stakeholder engagement, discouraging participants from becoming involved in the research.

As a result of these concerns, a short survey proposing various terms as alternatives to authentic assessment was designed, and stakeholders within the Education Enhancement department were invited to complete it. This suggested that the term ‘work-integrated’ assessment would be a more acceptable term, and hence this was adopted for future iterations of the model.

Model iteration 3: Work-integrated Assessment ‘Change Continuum Tool’

As has been described earlier, the research was carried out using as a series of micro iterations and macro iterations. As the design tool was becoming more stable, it was decided to move on from the very rough prototyping that had been previously used into a more high fidelity prototype that could be more thoroughly tested, and hence the research entered into another macro iteration.

Micro iterations testing the existing model with stakeholders had suggested changes which needed to be incorporated into the model. Most characteristics proved reliable and stable, they appeared to be working well and were not extensively commented upon. Feedback did suggest, however, that the ‘Transfer’ and the ‘People’ characteristics were not easy to design around.

From 'Transfer' to 'Review': At the heart of the 'Transfer' continuum was the notion that personal development outside of academic contexts tends to be more continuous and often catalysed by peer interaction. Formal instruction does certainly occur within professional contexts, but the bulk of actual learning takes place on the job with peers, where individuals develop through a form of cognitive apprenticeship (Brown, Collins and Newman, 1989). It was decided to rename this continuum 'Review' to better summarise this notion of working and developing through peers. On reflection, this better summarised the theme that emerged from stakeholders, so it is questionable why 'Transfer' was originally used.

From 'People' to 'Social': The continuum of 'People' also related to the notion of working with peers, but this time in a more formalised way of either working independently on within a defined group. The word as used was not easily understood, and it was decided to change to the word 'Social' instead to try and emphasise the notion of working with others rather than independently.

Adding 'Structure': One characteristic that the existing model did not cover explicitly was that of learning to work independently of others, of self-regulation, working without a defined structure. As has been noted, this was intended to be implicit in the model itself, but in practice this implicit sense meant that it was not addressed explicitly in redesigning assessment. In order to make this explicit once more, a new characteristic was introduced using the keyword of 'Structure'.

Finally, extra guidance text was added for each characteristics, turning them explicitly into design principles rather than simply characteristics. These changes are summarised in Table 7.6, below:

Characteristic	**Design principle**	**Traditional assessment**	**Authentic assessment**
Problem	Purely academic learning might require a theoretical problem in order to test a theoretical understanding. In employment though problems tend to be very real.	*Internally derived, theoretical idea*	*Externally focused, real world task*
Timing	Assessments are often delivered in the form of examinations at the end of learning. In employment however timing is often out of your individual control, and you usually have to juggle multiple tasks at the same time.	*Single, long term*	*Multiple, short term*
Data	The individual pieces of data that you need to work with in employment rarely come in coherent, standard forms. They are usually in 'messier' formats that need to be interpreted to be of use.	*Theoretical, 'perfect' data*	*Real world, messy data*
Review	The 'sage on the stage' mentality puts the academic firmly in charge of the review process. Extending the review process to students encourages a deeper understanding of the learning that has taken place, by requiring reflection over the way a task has been undertaken.	*Tutor review*	*Peer review*
Structure	Current thinking on assessment practice advises that assessments should be well structured, with clear guidance to students. However in employment part of the challenge of a task is to create the process(es) necessary to achieve it.	*Formal structure and requirements*	*Open challenge*
Social	Many forms of assessment require the assessee to work alone, yet in employment tasks invariably require some form of collaboration. Encouraging students to work with peers helps build their collaborative skills.	*Working alone*	*Working in collaboration*
Audience	The audience for an assessment is typically the academic that sets it. This contrasts with employment, where the audience for work done is a client. Focusing on different audiences provokes reflection over content, and new levels of synthesis.	*Academic, internally directed*	*Business, externally directed*

Table 7.6: Characteristics as design principles

This new model was designed to be printed in full A4, double sided, and is depicted in Figures 7.11 and Figures 7.12. A full scale version is also included in Appendix E4: Work-integrated Assessment Change Continuum Tool.

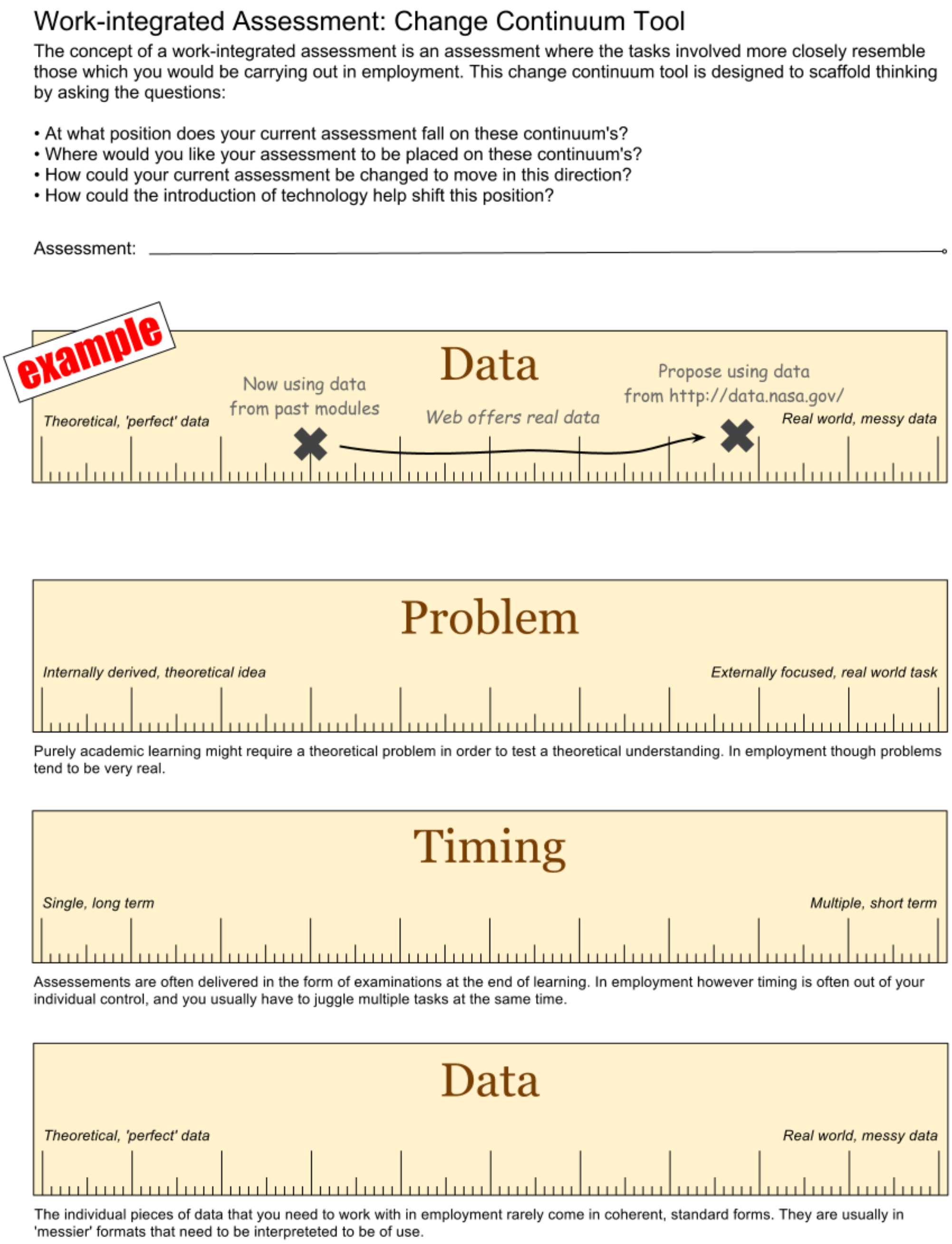


Figure 7.11: Work-integrated Assessment 'Change Continuum Tool'

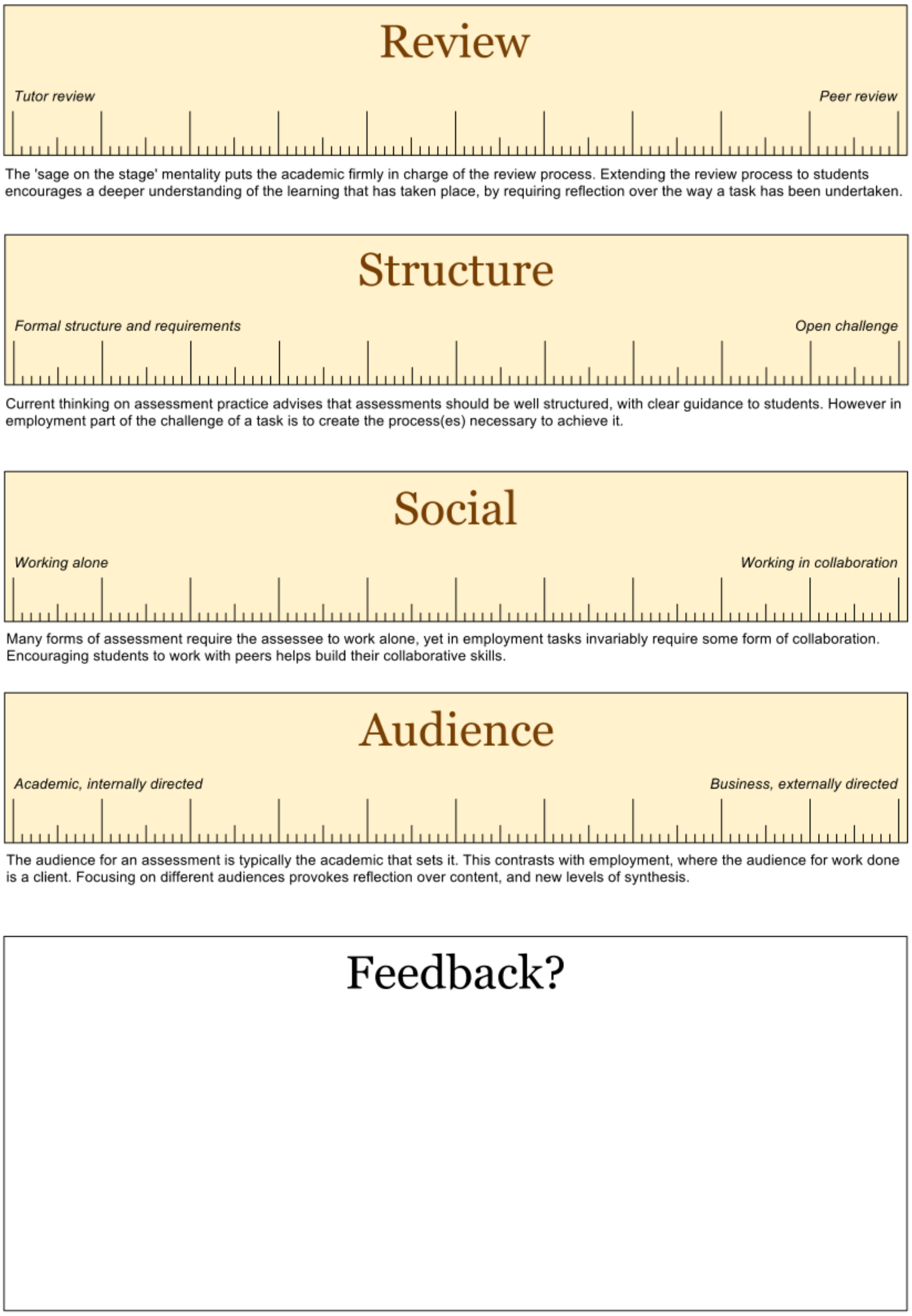


Figure 7.12: Work-integrated Assessment 'Change Continuum Tool' (page 2)

Once again this tool was designed to be used, to be filled in actively rather than just read, it was designed as a tool to prompt new thinking around existing assessments, or to aid in the design of new assessments, rather than simply as something to be read separately. Figures 7.13 show how this was envisaged in practice, with participants marking on the line existing and planned practice in order to design a change to an existing assessment.

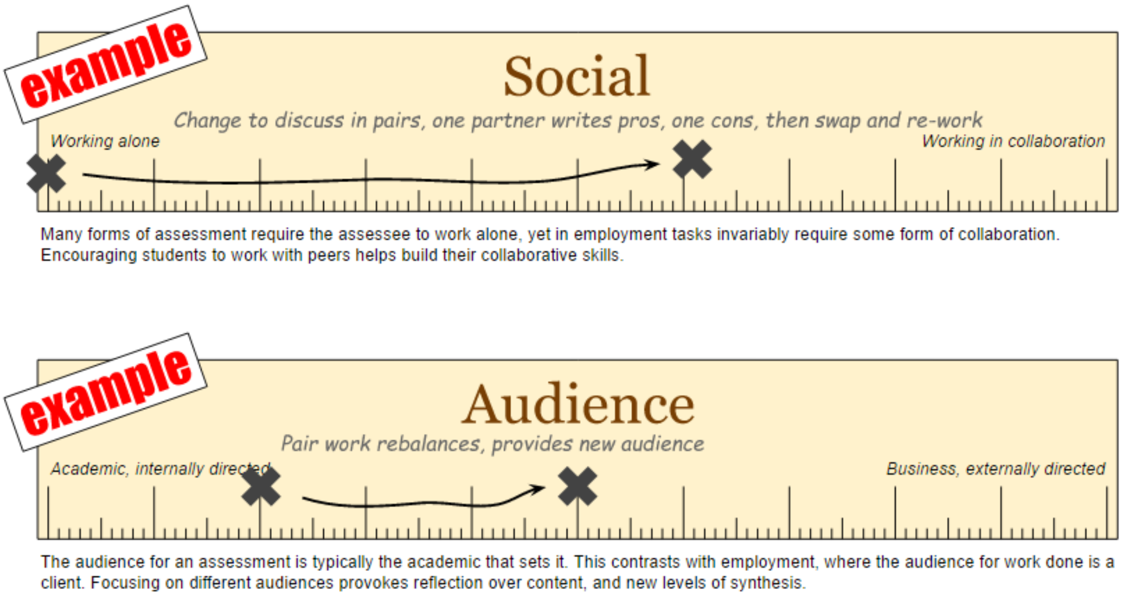


Figure 7.13: How the continuums were envisaged to be used in practice

This tool was shared with participants during several workshops, an example workshop is shown in Figure 7.14, and some concerns were noted. At a particular workshop in June 2012, participants highlighted a worrying problem with the overall design. The use of the linear continuums with two extremes tended to lead to positive and negative perspectives, isolating and reinforcing existing beliefs and polarising opinion. Any attempt to cast current academic practice near one end and authentic practice nearer the other suggested conflict between the two positions. Attempts to actually use the tool in practice often got bogged down in technical pedagogical discussion about the value of an authentic versus traditional perspective, rather than the intended capture of a pedagogical intention.

Figure 7.14: Typical workshop used for testing designed products with practitioners

A new model was sought which would reduce this tendency, with a more “value neutral” position that would allow for the exploration of assessments without negative connotations.

Model iteration 4: Dimensions of work-integrated assessment

The key driver for the next stage of model design came through a conversation. Reeves (2005) suggests that a key characteristic of design-based research is that it should be reported on regularly during the design process, in order that broader conversations outside of the design context might inform design choices. I had just completed presenting the work at a national conference, including the ‘rulers’ that were being used at the time as shown in Figures 7.11 and 7.12, to peers at another UK University. Whilst discussing the problem of positive and negative ends of these rulers with a fellow conference attendee, it occurred to me that there existed charts or visualisations which did not have explicit positive/negative connotations. The current model could be said to be using a bar chart type of visualisation, with each of the rulers suggesting a zero point on the left and higher ratings on the right, effectively something with no value on the left and positive value on the right. If the rulers were recast into another form of chart which did not have this same measuring effect against a fixed scale, such as a pie chart or radar/spider chart, then the problem of perceiving negative positions versus positive positions might disappear.

It was decided to trial a radar chart for the model, which has no right and wrong ends and therefore does not suggest positive and negative positions. The characteristics shown in Table 7.6 were collapsed from seven to six, with the problem and data continuums combined as these seemed to define the same need, and they were arranged in a hexagon shape. The work-integrated assessment definition was slightly embellished to become “an assessment where the tasks and conditions are more closely aligned to those experienced within employment”. This produced the next iteration of design principles for work-integrated assessment, as are listed in Table 7.7, below. These design principles have been written in the style of Van den Akker (1999), as discussed in Chapter 5 of this thesis. They attempt to provide a characteristic that needs to be designed, a procedure through which this might happen, and an argument as to why this is important (Van den Akker, 1999, p. 9). The previous text defining the contrast between a traditional assessment and an authentic or work-integrated assessment was removed.

Dimension (characteristic)	**Design principles (procedure / rationale)**
Problem / Data	*Set a real world problem as the core assessment task, supported by real world data* Purely academic learning might require a theoretical problem in order to test a theoretical understanding. In employment though problems tend to be very real, and data rarely comes in coherent, standardised forms. It is usually in 'messier' formats that need to be interpreted to be of use. Using a real world problem and real world data helps to develop skills in analysis, interpretation and evaluation.

Time	*Move to a more distributed pattern of assessment; consider introducing 'surprise' points* Assessments are often delivered in the form of one summative assessment, e.g. an exam or essay, at the end of a period of formal learning. In employment however, 'assessment' or evaluation points tend to occur frequently. In addition, timing is often out of individual control, and consequently it can be necessary to juggle competing tasks at short notice. Using multiple assessment points helps to develop reflective thinking, whilst 'surprise' points support task prioritisation
Collaboration	*Create teams of students who work together to complete the assessment, encourage collaboration* Many forms of assessment require working alone, yet employment invariably requires some form of collaboration and teamwork, and often with unknown and perhaps even challenging individuals. Encouraging students to work collaboratively and in teams improves their ability to negotiate and discuss, and develops their understanding of team roles and role flexibility.
Review	*Include peer and/or self review explicitly in the assessment process* Typically the review of assessments (i.e. feedback) in formal education is only provided by teaching staff. In employment, however, much of the review process comes in multiple forms, e.g. informal peer feedback from colleagues, formal and informal reviews from clients, and self review of personal performance. Including peer and/or self review explicitly within an assessment helps students to develop critical thinking skills, and encourages articulation and evidencing.
Structure	*Lightly structure the overall assessment; reward student approaches* Most thinking on assessment suggests that there should be explicit guidance to students concerning how and where marks are attained. However in employment part of the challenge for the individual and/or team is the structuring of the work that needs to be completed. Tasks need to be identified, processes decided, and priorities allocated. Using a light structure approach encourages students to plan tasks and goals in order to solve a bigger problem, strengthening their project management and prioritisation skills.
Audience	*Aim to set explicit audiences for each assessment point* In higher education the audience for an assessment is implicitly the academic that sets it, who will naturally be already aligned in some way with the course and/or module. This contrasts with employment, where the audience can be peers, but is more often the client or another external third party, with different values, priorities and expectations. Having to think for a different audience on an assessment provokes greater reflective thinking, and requires new types of synthesis.

Table 7.7: Final six 'dimensions', design principles for creating work-integrated assessment

The original version of this new model, the 'Dimensions of a Work Integrated Assessment' is depicted in Figure 7.15, below:

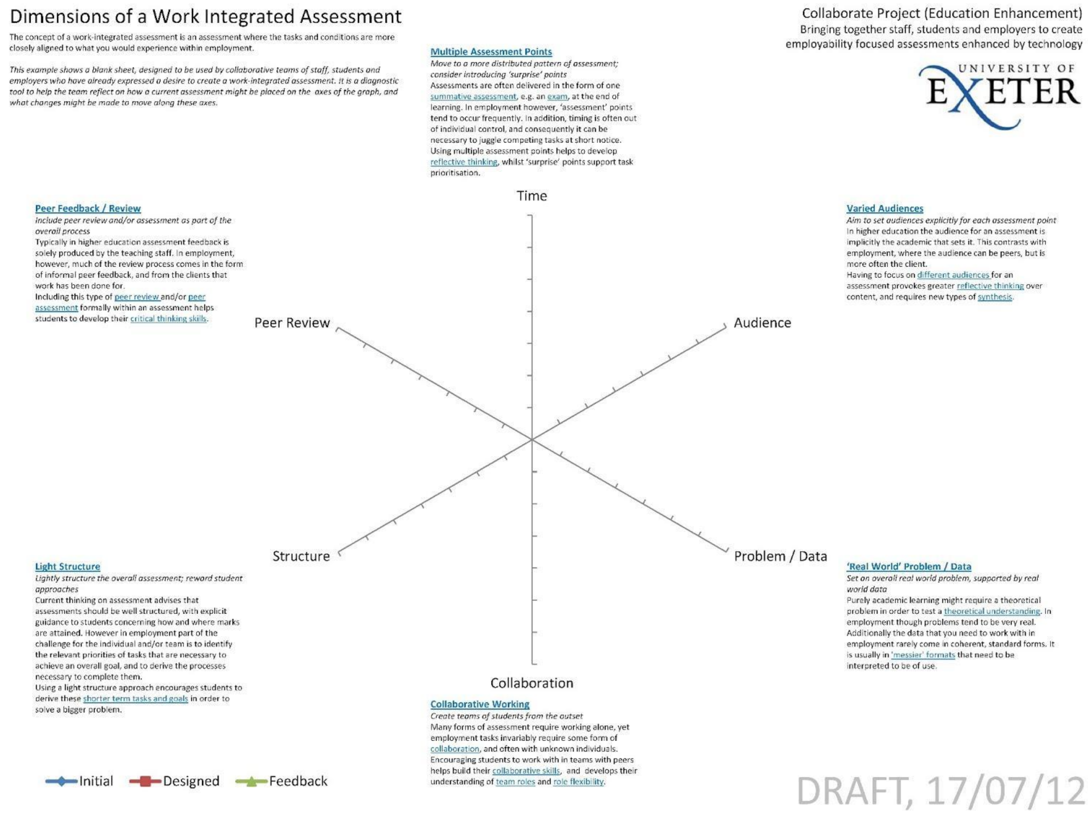


Figure 7.15: Original 'Dimensions of a Work Integrated Assessment' model (with design principles as outlined in Table 7.7 arranged around the chart)

It was also decided to move away from the notion of 'characteristics', instead adopting the term 'dimensions'. The use of the word dimensions was purposeful. The word dimension can have several definitions, but all are connected by a sense of measurement: the dimensions of a door perhaps, or of a place. As the purpose of the model that was being designed was to frame and drive intention, then what was required was a way of measuring how much an intended assessment wanted to embed each one of these characteristics in turn, i.e. not simply to identify that one of them was important, but also to describe *how* important each was in a specific context. The purpose of the redesigned model was to provide both a thinking tool, using the dimensions to stimulate discussion, and a redesign tool, annotated in order to visualise and agree collective thinking. The model then serves as a conceptual space for thinking about assessment, it creates an artificial space constrained by the six dimensions, within which thinking can then be focused down to a specific context. From an ecological perspective, the dimensions model could be said to provide a conceptual space within which individuals can find their particular *niche* within the broader potential *habitat* of authentic or work-integrated assessment as provided by the model. It captures their specific pedagogical intention.

By providing a pedagogically valid boundary around a particular teaching and learning context to frame thinking, it could perhaps be said to provide a 'dialogic space' (Wegerif, 2007), where the responses to dialog are provided by the artefact itself, the dimensions, and the way they are framed around the radar diagram. It suggests possible directions without prescribing them, giving freedom for personal interpretation but within (useful) constraints, and allowing pedagogical intention to be captured explicitly and definitively.

Using the model in practice

The dimensions model was printed on A3 sheets, designed to be used by collaborative design teams of academic staff, together with employers, students and other staff as appropriate, to capture pedagogical intention and hence change existing assessments. The model is both a thinking tool, using the dimensions to stimulate discussion, and a redesign tool, annotated in order to visualise and agree collective thinking. It is used in three stages, each of which is marked on the chart:

1. *Analysis:* Thinking about a current assessment, plotting on the chart where it might lie on each of the dimensions.
2. *Design:* Discussing how to move along the dimensions, i.e., how changes to the assessment might be introduced and what impact this might have.
3. *Evaluation:* Determining how well the designed changes have worked in practice.

The analysis and re-design stages are intended to be completed at the same time, the evaluation stage after the module has finished. Figures 7.16, 7.17 and 7.18 show idealised versions of these three phases of the model.

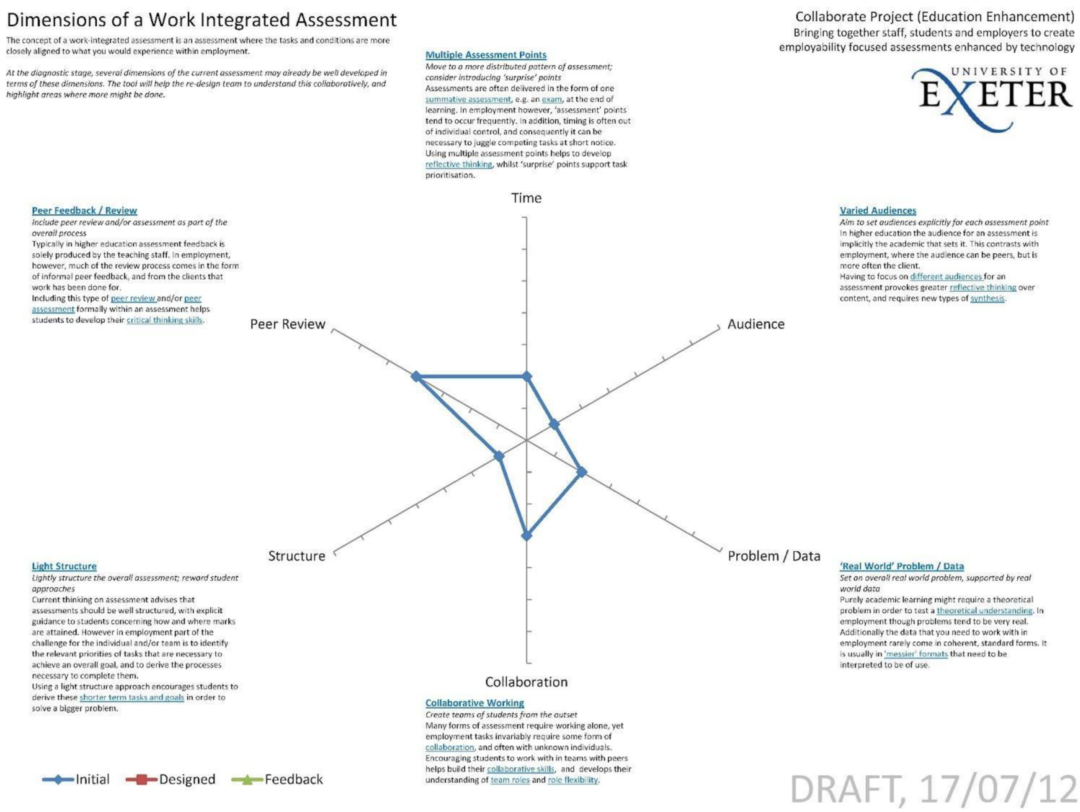


Figure 7.16: Example of phase 1 of the 'Dimensions of work-integrated assessment' model, showing the analysis (initial) polygon

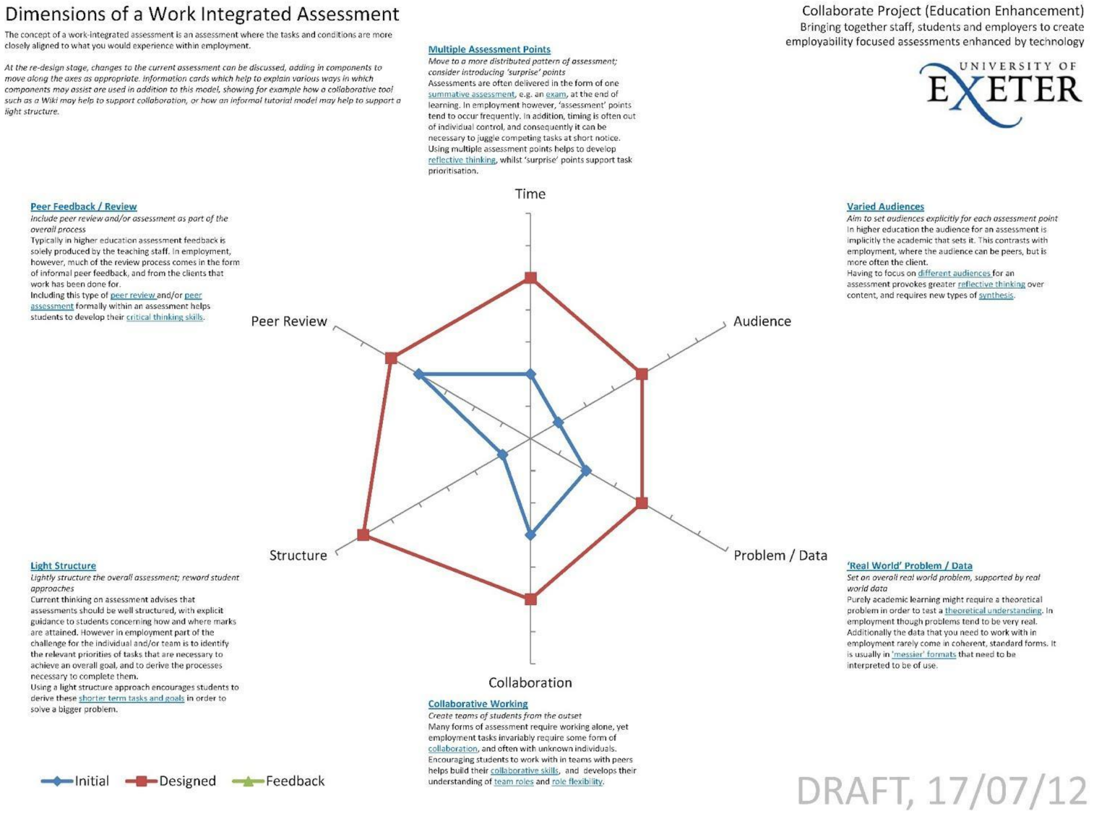


Figure 7.17: Example of phase 2 of the 'Dimensions of work-integrated assessment' model, showing the design polygon

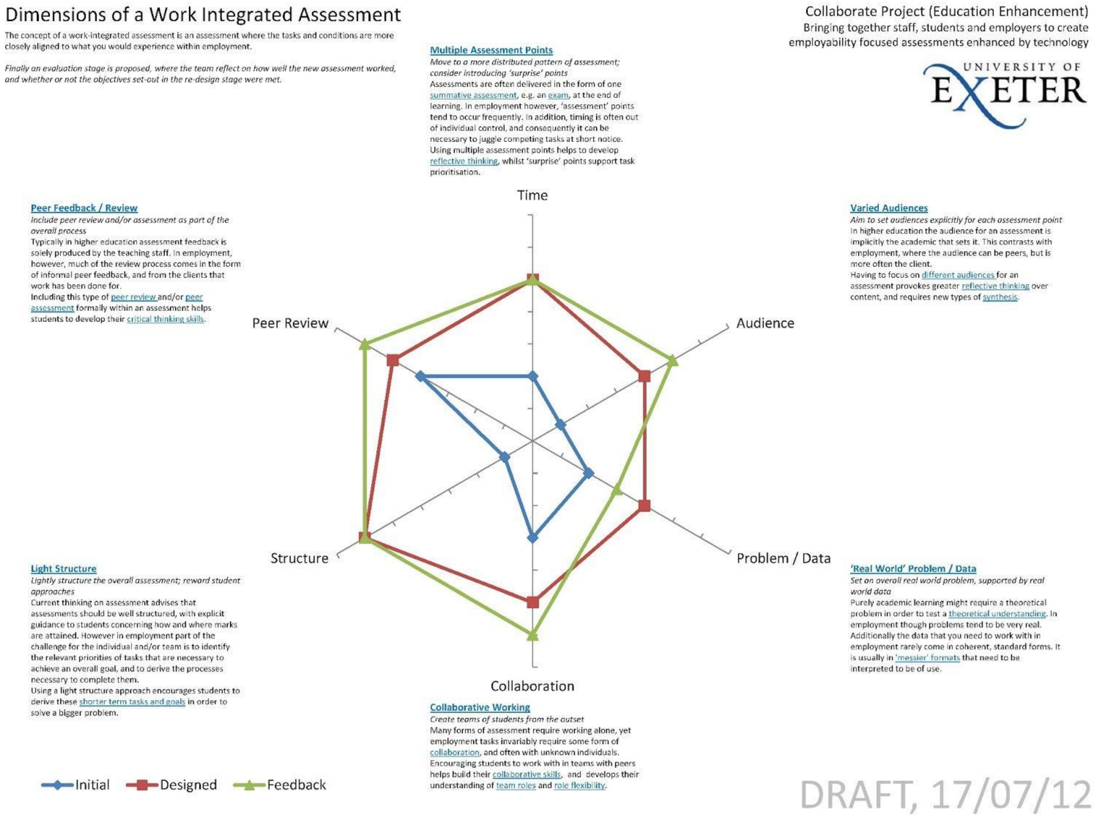


Figure 7.18: Example of phase 3 of the 'Dimensions of work-integrated assessment' model, showing the evaluation (feedback) polygon

The aim was to fill in the model, and annotate it directly in order to suggest new aspects to an assessment. A model which was completed during an intervention in this way, GEOM150 (Social Enterprise, Environment and Sustainability I) as listed in Table 7.2, is shown in Figure 7.19, below:

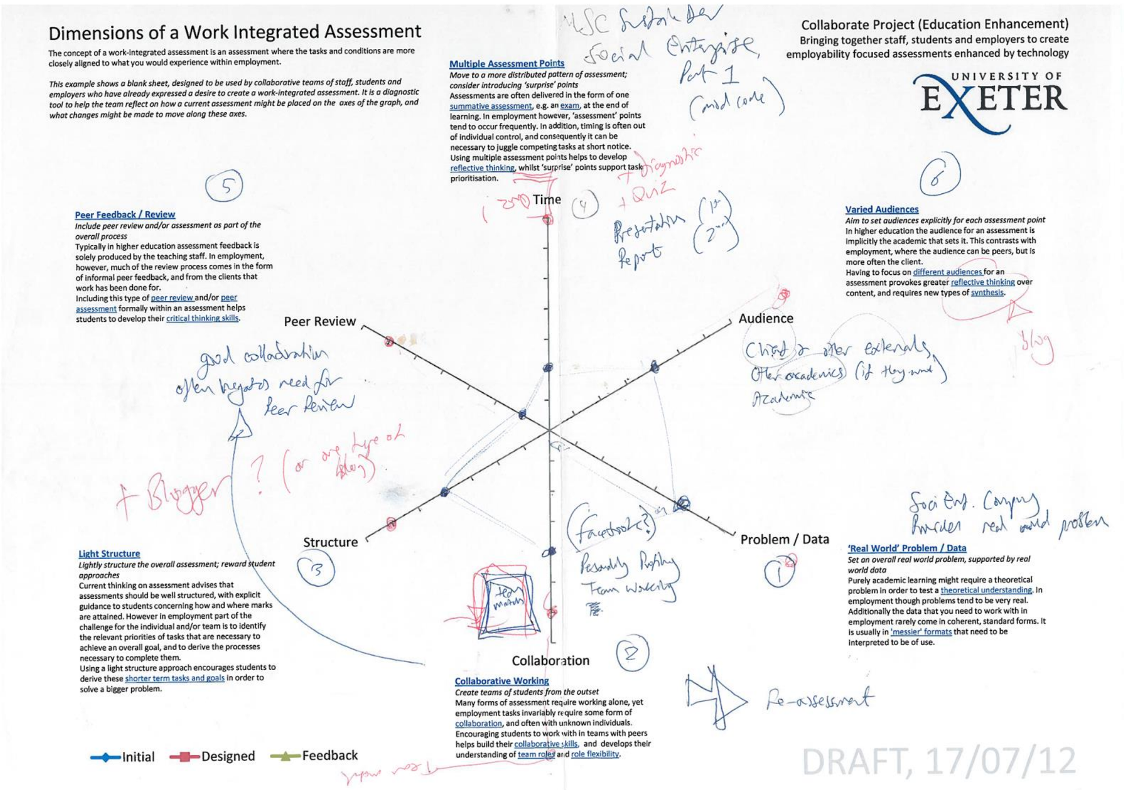


Figure 7.19: Completed version of the original 'Dimensions of work-integrated assessment' model

Measuring against the dimensions

It is perhaps notable that the model does not use any numeric scale: no numbers summarise the length of each dimension, and no rubric or guidance is given as to how far along any one dimension a particular aspect of an assessment might be placed on the line. It does include tick marks, seven on each dimension, and these might provide a scalar measure, but this is never made explicit.

There was some discussion in the design stages about the merits of further quantifying or qualifying the range and tick marks of each of the dimensions, so that it might be clearer to those new to the model how to complete it. For example, some illustrative text might be written that would show the difference between a mark at 7 on the dimension for audience, as opposed to a mark at 5, similar perhaps to the way that marking guidance might be written, showing the difference between a 1st class mark and a 3rd class mark. After much debate and experiment though it was decided that this was not necessary, and in fact might negatively impact how individuals completed the model.

In practice it was observed how individuals would generate their own method of rating themselves against each dimension, and then apply this in order to sketch out both their current practice and their desired new design. Users seemed to construct their own meaning from the model, with the model itself only serving as a scaffold for their thinking. For example, one academic decided where they were already particularly strong on the model, and gave this a top mark, and then allocated other dimension marks in relation to this first mark. Others would try to quantify their existing practice against the tick marks, for example one audience would merit one tick, two audiences two tick marks, and so on. Some academics were very precise in their measurements, moving between tick marks and spending considerable amounts of time deciding of very small measurements. Others were much more relaxed about the precise marks, and used a much broader range on the dimensions.

Figure 7.20: Academic (Law) completing the dimensions model

The obvious weakness of this approach is that it makes comparing models that have been completed by different individuals very difficult, as they will not have the same baseline. However the model is designed to provoke thinking in one instance of redesign, it was not originally intended for comparative work across modules or programmes. This flexibility of use that was seen in practice seemed to be a strength of the overall design, not a weakness, and hence it was decided against more defined measurements, in order to support these personal interpretations of the model.

The redesigned model proved very successful with academic staff, illustrated most powerfully by the fact that it needed very little explanation in use. It was tested in multiple disciplines, with different academics at varying levels of expertise and teaching at various academic levels. In all cases it was well received and appeared to serve its purpose in prompting thinking. Thirteen copies of models that were used in real contexts are included as Appendix E5, which give a sense of the range and type of annotation and use.

Small tweaks and changes were made to the model over the macro iterations planned, but it remained on the whole remarkably stable, with the final version as shown in Figure 7.21 (also included as Appendix E11) almost exactly the same as the original design. There was one significant change, the dimension of peer feedback / review was broadened out to cover all forms of review, either self or peer review. As with the structure dimension, on referring back to previous work on themes from interviewees it was noted that the original concepts were more closely related to review generally, rather than simply peer review, so it was again questionable how this dimension has originally been so narrowly defined.

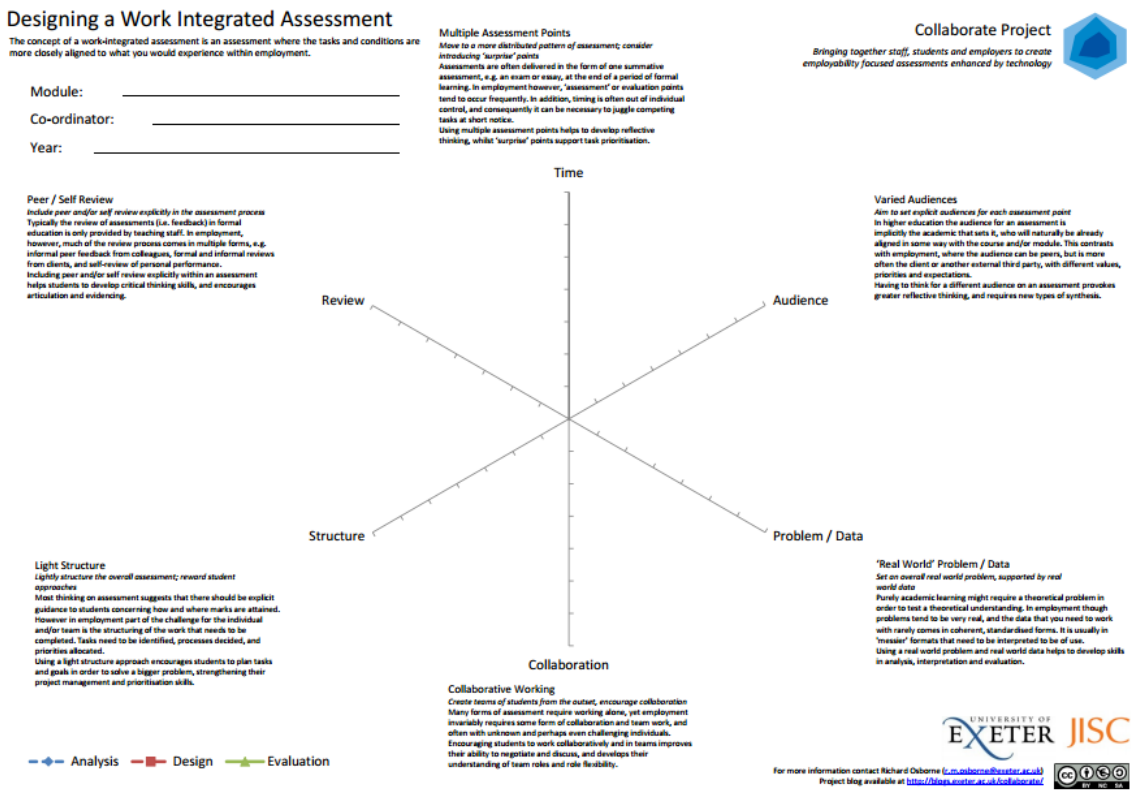


Figure 7.21: Final 'Designing a Work Integrated Assessment' model

It might be said of empirical research that the first impulse is always to attend and to what the data is saying, to try and interpret from data. What is perhaps not as equally discussed, and what also became apparent at School A, is the need to be aware of, and attend to, what the data is *not* saying. What was not happening that happened previously, what changed as a result of redesign. In the case of the dimensions model, what changed in its new radar chart design was that individuals no longer questioned it. Instead of the model being a point of contention and discussion in itself, it terms of its form and its contents, participants were much more inclined to simply ‘leap in’ and use it. Two potential key reasons are suggested that explain this. First, that the heart of the model is an open space that invites completion, from an affordance perspective what it might be said to provide is a space for thinking. Second, it uses the language of the practitioner, the language of the ‘community of practice’ that it is designed for, no internal decoding or translation is required by academic colleagues in order to understand it. These ideas will be returned to in Chapter 8.

This concludes Phase 1 of the work at Exeter, which set out capture the pedagogical intention of key participants, the first part of the affordances trinity, in order to produce a practical designed artefact which could allow intention to be defined. This should provide a starting point upon which affordances might be aligned. The dimensions model of work integrated assessment provided this practical designed artefact, and hence completed the first part of the design framework

Phase 2: Identifying invariance of digital places

The next phase of the research intended to better understand the second part of the trinity of affordances and the initial design framework as outlined in Chapter 6, that of invariance. It did not attempt to identify generic invariants of all technology, such an undertaking would be well beyond the remit and capacity of the current research, instead limiting itself to aspects of digital technologies that were deemed relevant by participants. Critically the objective was not to seek out only invariant properties of digital technologies, but more broadly the invariance of digital place. Chapter 4 has argued that by conceptualising digital technologies as place, new invariants in those places and hence new affordances may become apparent.

This first part of this phase analysed participants interviews for insight into the way in which digital technologies were currently being used in practice.

Themes emerging from participant interviews

Don't rule anything out

There was no clear message from interviewees about the role that technology might play in re-designed assessments. In fact the question about technology in particular proved difficult for the majority of interviewees, even after several iterations designed to make the question easier to respond to. This question passed through the following iterations:

- First version: What role do you think technology should play within assessments?
- Second version: How do you think technology could be used to improve assessment practice?
- Third version: Which technologies do you currently find most useful in your work?
- Fourth version: Are they any technologies that you find particularly useful in your work?

Initial attempts to align the question with assessment caused confusion, so it was changed so as to try to provoke thinking about technology more generally, but the question still proved to be difficult for interviewees. It is possible that it is an implicit problem with the word 'technologies', as Arthur (2009) observes, the definition of the word 'technology' is not always clear, and different groups and individuals have different perceptions of what technology means, and this in turn can differ in different contexts. Considering that 'technologies' may be as broad as an entire VLE, or something as specific as a video camera, it is perhaps not surprising that interviewees struggled to conceptualise exactly what the question was attempting to understand.

A potential underlying cause is that there is no easy way to see how any one type of technology by itself could be utilised within assessment in order to improve employability. It is much more likely that a combined approach utilising several technologies is necessary, a form of ‘bricolage’, i.e. “the construction or creation of a work from a diverse range of things that happen to be available” (Wikipedia).

What was clearer from the interviews was that no technologies were particularly *ruled out* as being inappropriate for learning, many different technologies were discussed including those that might seem perhaps to have little relevance, e.g. social media tools.

> “Something that makes them use social media and social networks in a professional context instead of in a social context, coz rather than just telling them you’ve got to build, you know professional online presence or something like that, actually something that, ermm, really gets them to put that into practice.”
>
> College Employability Officer

The conclusion drawn from this theme was that the no technologies should be purposefully left out, i.e. there did not appear to be any assessment specific technologies that should be focused upon in order to support a specific pedagogical intention. As the quote above indicated, the answer does not lie in the specific technology itself, but in the way in which it is used in a specific context. By choosing a broad range of technologies, and placing their use in context, their specific value within that context should become more apparent.

Let students choose

There was a sense that students already bring with them powerful devices and specific expertise in software that can be tapped into in order to drive student engagement with tasks and to make the most of what they have - both in practical terms and theoretical terms. This applied to both hardware and software. Although the term Bring Your Own Device (BYOD) is now quite commonplace, there is a sense in which this is focused around hardware more than software.

> "They've got all this kit on them, and they're fiddling away with it even when you don't want them to be, ermm, so let's just encourage them to use it, and they do really like this type of exercise."
>
> Employability Manager

However in general interviewees were reflecting over the students' use of specific software or web apps, not on particular devices, what has been referred to as Bring Your Own Service (BYOS). One academic colleague in particular has now changed their practice as a result of experiences with students, removing the requirement to use a specific technology therefore allowing students to make the most of their existing skillsets and expertise.

> "Now my handbook says you have 20 minutes presentation ... doesn't say anything about technology, because I am so surprised every year ... I mean last year I had 3D flythroughs ... I was like, how the hell do you do this"
>
> Academic, Business School

Other academic colleagues specifically set out to choose technologies that provided both affordances and constraints, in order to create protective boundaries around the students use of technology, but again let students choose their own path if they wished.

> "I suggest that they use Google Sites ... but I also tell them if they want to use a different one they can use a different one ... the reason I do that is that Google

> Sites is actually, it's, ermmm, it's a little bit restrictive, but it stops them going too badly wrong."
>
> 7Academic, Biology

There are potential equity issues with this approach, in that those students who are more digitally literate may be able to produce higher quality work (at least from an aesthetic perspective), but arguably the use of strong marking criteria and guidelines should mitigate against this if a rigorous assessment rubric is adhered to.

> "Technology plays quite an important role in the module ... but we don't force particular solutions on the students. What we get them to do very early on in their project is identify what the risks are with working as a team, and these include things like making sure that data is available to everyone and having multiple copies of documents and then help them identify potential solutions in their project that will work for them."
>
> Academic, Mathematics

The conclusion drawn from this theme was that technologies should be usable on as broad a range of devices as possible. Limiting a technology to a specific device limits where it can be applied, and by whom. It also suggested that a range of potentially similar technologies should be proposed in each case, to meet individual need, rather than specifying one technology to be used by all. This would be in line with the relational nature of affordances, i.e. the fact that they are personal.

Be mindful of levels of digital literacy

There has been a consensus that technology does have a role to play in assessments. Yet, because it is different to the traditional forms such as essays or exams, there is understandable anxiety from those who do not see themselves as being digitally literate and indeed, those who do still feel that there needs to be a mixed approach.

Therefore it is important to create visible support for students where technology is used as a part of their assessment.

> "I was thinking of doing a module this year in my final year, and one of the things which put me off was the use of social media and making a video as a form of assessment. I wasn't comfortable doing that as it felt like a bit of a risk having not done it before"
>
> Geography student

> "It's very easy for them to quantify what a 3,000 word essay looks like, because it has 3,000 words in it, but if you ask them to create a blog, or a presentation, or a mind map, or a wiki, they're going to go, well, how much do I have to put?"
>
> Learning Technologist, Social Sciences

Academics in particular have noted how some students reject the introduction of technology into their courses, and indeed have even used their own low level of digital literacy as an excuse for poor performance or engagement. It is widely believed that young people are inherently more skilled and comfortable with technology than older age groups, the so called digital native concept (Prensky, 2001a, 2001b) but this myth has now been largely discredited (Bennett et al, 2008; Kennedy et al, 2010). As described in Chapter 4, later work by White (2011) suggests that a model of visitors and residents may be more appropriate. A young age does not necessarily confer implicit technological expertise, especially when applying these technologies within educational contexts.

Any technological intervention needs to be introduced with appropriate support in place if it is to be successful. There could be an argument to embed these new practices at an early stage in the programmes. This will give students confidence in selecting modules which use technology and essentially give them additional qualities which are not available through traditional methods of assessment.

> "Maybe if in the first year everyone was brought up to speed on using a particular technology then you could be assessed on it later."
>
> Geography student

The conclusion drawn from this theme was twofold. It reinforced the notion that any framework devised should propose several technologies that might have the potential to support a given context, therefore increasing the probability that individuals could select something they felt familiar with to support their studies, or at least perhaps had heard of and were willing to try. It also suggested a focus on mature technologies with existing support structures and communities, this should help to ensure the overall stability of the technology, and provide methods for understanding its use and seeking help with problems when these were encountered.

Be mindful over discipline specific challenges

An emergent finding from working with pure science students was that their lab work was written up in special 'lab books' that are completed in real time during lab sessions. These books are often then presented as part of their assessments. Critically, the lab books can show errors and problems as well as progress and successes, and this is a crucial reason for using them. It is a necessary part of science to be able to understand where things have not worked, as well as where they have worked, so the lab book is not a perfect piece of idealised assessment, but instead an ongoing log of scientific work.

Lab books are also created using a blend of knowledge representation, using not only text but also diagrams, scientific equations, charts, etc. As such they are not well suited to digitisation, as there are very few forms of technological representation that can allow both quality and variability of input at the same time. Most technologies either allow typed input, very rough touch input, or idealised drawing capabilities through a mouse and virtual toolbox that produces images ‘too perfect’ for proper scientific work.

This is perhaps best represented by looking at the logbook of a very notable scientist (Figure 7.22), Sir Isaac Newton, and noting the way he uses not only standard typology, but also relative space and non-standard symbology to represent his thinking. Most current digital technological solutions cannot support this level of detail in note taking.

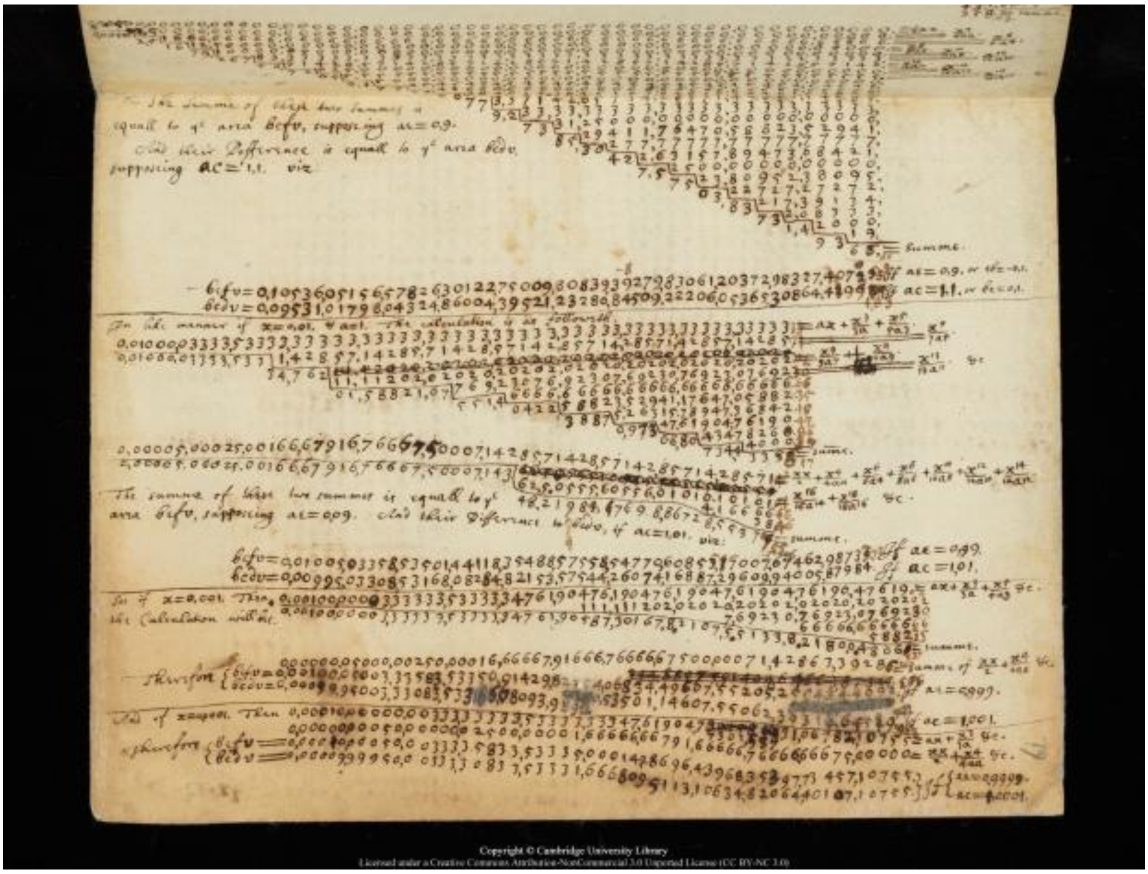


Figure 7.22: Example page from the logbooks of Sir Isaac Newton

The conclusion drawn from this theme was that the use of technologies should not be compulsory. Interviews may have highlighted specific instances where technology would be inappropriate, but from a practical perspective it would be incredibly time consuming and perhaps even impossible to catalogue every match where specific technologies which might not have the capacity to meet discipline needs. By simply proposing technologies that had the potential to support a specific pedagogic intention, but not insisting on use, the likelihood of technologies negatively impacting learning by imposing unwanted constraints on learning should be reduced.

Focus on learning

A popular reason for the introduction of a technology based assessments into modules is simply to make assessment more efficient for larger cohorts of students. This use of technology in an administrative capacity is powerful, as it can not only save money but also allow the introduction of assessments were they otherwise might not be possible. Online multiple choice questions (MCQs), for example, were seen as an ideal use for technology, as this a mature and well tested form of assessment. There was however perceived to be a 'break even' point of around 100 students in terms of efficiency versus effectiveness.

> "The attraction is the numbers, it gives you a mark... with the online assessment it does it all for you"
>
> Learning Technologist, Business School

A possible negative effect of their use was observed, that the use of MCQs naturally exposes students to a large degree of wrong answers or 'distractors'. For weaker students in particular this might lead to the memorisation of wrong information.

It is perhaps important therefore to distinguish the use of technology from a pedagogical standpoint, where the purpose is to enhance the learning process through the use of technology, with the use of technology to assist in the delivery of an assessment. This is perhaps best contrasted as Technology Assisted Learning versus Technology Enhanced Learning (or alternatively Technology Assisted Assessment versus Technology Enhanced Assessment - though if assessment is considered as an integral part of learning, then this distinction is perhaps unnecessary).

The conclusion drawn from this theme was that technologies should be selected for learners, not for administrators. The focus of the present research is on direct support for individual learners, on effectiveness and not efficiency.

Include institutional technologies

The University had been making a concerted effort to ensure that all academics and all courses run by the University do have individual sites within the official virtual learning environment (ELE), and although this has been resisted in some sectors and by some individuals practically all stakeholders interviewed now seemed to appreciate the value that this virtual space can provide for their students.

Even if the VLE itself was being used solely as an information repository for content, the very fact that this content could be shared so directly and so easily with the specific group of students on the course did lead to more effective overall communication between academics and students. This may not directly equate to enhanced learning outcomes, but is an important component of the overall student and staff experience.

This suggested that 'official' central technologies should be included within any wider framework to align pedagogy and technology, which might also help to mitigate against nervousness associated with using unfamiliar technologies.

Think laterally

There was a sense of missed opportunity for some digital technologies. Students seemed aware that there were many different technologies available to use, but were not sure what value they might have, i.e. what specific use they offer in a particular context.

> "I just need to know what programs do what ... there's such a big list of programs I don't actually know what they do and they could be very useful for me."
>
> Undergraduate student, Geography

Another way of interpreting this student's statement would be to say that she doesn't know what the technologies provide for her, they have no affordance.

There was also a sense that technologies could be used in flexible ways to suit different needs, or that different technologies might be appropriated than would perhaps be expected.

> "I think employers are always looking at ways in which new generations are using technology and in ways they haven't necessarily thought of. So even making a film instead of an ordinary PowerPoint presentation shows different initiatives and skill sets."
>
> English student

This theme suggested that single technologies could be adapted to suit different contexts, and echoed research at School A which appeared to show an underlying invariance being used to provide multiple affordances.

Choosing specific technologies

Analysis of the interviews provided the wider socio-cultural invariances of the use of digital place as understood by participants, such as not ruling anything out, letting students choose, focus on learning, etc. What also emerged from participants interviews but perhaps is more implicit than explicit is that *specific* technologies were being used. When digital technologies were used successfully to support studies, it was a particular technology that was being used, not a generic technology category.

The phrase Bring Your Own Service, or BYOS, may be useful from a top down perspective as it clarifies that it is important not to be prescriptive in defining what technologies should be allowed, but it perhaps hides the underlying meaning within the statement that students are selecting specific technologies based on individual preference. They do not choose ‘blogs’ they choose Blogger or WordPress. They do choose simply to do something ‘online’, they choose a specific technology such as Google Sites.

The star diagram in Figure 7.2 illustrated a broad range of digital technologies that were initially planned for the research. However, on reviewing this selection of technologies it was clear that they were not all the same type of things, it could be said that there was something of a category mistake (Ryle, 1949) in arranging such as diverse collection of technologies under one heading. ‘Twitter’, for example, is a unique micro blogging service, whereas ‘Online’ is a generic statement of approach. ‘Audio’ is a type of media that might be included, whereas ‘MCQs’ (i.e. multiple choice questions) are a standard form of assessment which may be used independently of technology. A ‘VLE’ might be anything from a massive corporate system hosting thousands of courses to a bespoke personalised learning environment for small group teaching, whereas ‘Search Techniques’ describes a skillset used to customise and focus results gained through the use of internet search engines. The star diagram contained specific types of technology, e.g. Twitter, broad categories of technology, e.g. VLEs, and methods of using technology, e.g. search techniques, all in the one group. Analysis of the interviews suggested that what was needed was to extract only specific technology types. However, reducing the technologies from the star diagram to specific technologies provided only 6 technologies: Excel; Facebook; Google+; Google Docs; Skype; and Twitter, and it was thought this would not provide a broad enough range of invariant properties for alignment with the pedagogical intention, as captured in the dimensions model described in Phase 1.

An alternative approach to using technologies is to use categorisation approaches, and I have been involved in many projects over the years which had attempted to do this. One of these previous attempts grouped technologies according to a hybrid of the types of actions they supported, e.g. blogging, information analysis, messaging, etc., and some more functional groupings, e.g. social networking, wikis, etc. and is shown in Table 7.8.

Types of Actions	**Specific Technologies Covered**
Audio, Images and Video	Audacity, Flickr, Picasa, YouTube, Digital Cameras, MP3 recorders, Podcasting
Blogging	Blogger, WordPress
Collaboration and Messaging	Connect, ConnectNow, Live Meeting, Skype, Yahoo Messenger, Live Messenger, Google Talk, Twitter, WebCT, Moodle, CMAP tools
Information Analysis	SPSS, NVivo, Excel, Databases, Limesurvey, Survey Monkey
Information Gathering, Bookmarking and Referencing	RSS, Google Scholar, Google Alerts, Databases, Google Books, Search engines, Google bookmarks, CiteULike, EndNote, Delicious
Location based tools	Google Earth, Google Maps, Microsoft Maps, Virtual Earth
Online and Portable Applications	Office Live, Google Docs, Zoho, Buzzword, Portable Apps
Social Networking	The Hive (Elgg), Facebook, MySpace
Wikis	Wikipedia, School Wiki

Table 7.8: Potential technologies from development sessions for researchers (2009)

A later development of this model aimed at improving general digital literacy grouped technologies according to their intended function, and can be seen in Table 7.9.

Technology Function	**Specific Technologies Covered**
Collaboration	Skype, Facebook, Adobe Connect, Jabber, Elgg, Confluence, Acrobat.com, LinkedIn, MySpace, Wikipedia, Second Life, Messenger

Creation	YouTube, Ustream, Google Docs, Flickr, Camtasia, Audacity, Picasa, Prezi, Cooliris, iTunesU, Audioboo, Zoho, Garageband, Vimeo, Photoshop, GIMP, Office, Screenr
Information	Google Alerts, Google Scholar, Zotero, CIteULike, Mendeley, Quickmark, Excel, Limesurvey, Endnote, Google Analytics, NVivo, SurveyMonkey, Delicious
Location	Google Earth, Google Maps, Google Streetview, Layar, CampusM
Publication	Twitter, Blogger, Wordpress, Tweetdeck, FeedDemon, Google Reader, Tumblr

Table 7.9: Potential technologies from technology showcase sessions (2010)

These two previous approaches were combined and added to those from the star diagram. Technologies which were seen as too inflexible, for example because they only worked on certain operating systems, were rejected. Technologies that were not free at point of use for students were also ruled out, as interviews had suggested it was important to let students choose their own technology. Institutional technologies were added, as suggested by participant interviews. This provided an initial pool of flexible digital technologies, and therefore potential invariants for alignment. The complete list of technologies is listed in Appendix E9.

Phase 3: Aligning intention and invariant through affordances

The purpose of phase 3 was to identity the transactional ‘space of possibilities’ of affordance that links intention and invariant.

Research at School A had suggested that intention and invariant, key aspects of the affordance trinity would need somehow to be aligned if affordance itself could be considered as a design tool. The theory of affordances has three characteristics that it is suggested may allow technologies to be aligned with pedagogy using an affordances approach:

- An affordance is stable, and it “does not change as the need of the observer changes” (Gibson 1979, pp. 138–139) and exists whether or not it is attended to (e.g. for someone who knows how to read, a book affords reading whether or not they have the intention to read it). This stability of affordances should allow the theoretical alignment of multiple technologies with a specific pedagogic model.
- Any one object/space has multiple affordances, with the affordance that is attended to based on need. “Needs control the perception of affordances (selective attention) and also initiate acts” (Gibson, 1982, p. 411) (e.g. a book can be read, thrown, burnt, etc., but only the affordance that matches need will be attended to). This flexibility of affordances should allow learners to meet their individual pedagogic needs.
- Affordances are personal and relational; that is, a specific affordance is relative to a specific individual (e.g. all books may afford reading for a literate adult, but the philosophy of John Dewey may only afford comprehension to far fewer). This relational nature of affordances should allow individuals to select from multiple technologies based on personal needs and experience.

A new questioning technique was developed, using the language of affordances, to try to align the pedagogic intention captured in the dimension model in Phase 1 with digital technologies as identified in Phase 2. Going back to Gibson’s original definition, and constantly referring back to the two keywords of ‘provide’ and ‘furnish’, this questioning technique attempted to prompt thinking as to what a specific digital technology might provide or furnish, given the pedagogical intention as prescribed by the dimensions model. The purpose of this type of questioning technique was to force the questioner to think about the context for learning, about a specific instance where an affordance might be picked-up, and explore how invariants within a specific digital technology might give rise to affordances relevant to that context.

The specific guidance for each dimension is shown in Appendix E6, and replicated here in Table 7.10 for clarity:

Dimension	**Question**	**Example**
Time	*Does the technology provide a way to create and manage related content over time?*	Example: diary formats, such as those used by blog tools, tend to be highly structured in time, providing an instant framework for multiple submissions and therefore self-reflection, so might rate 4 or 5 stars.
Audience	*Does the technology provide a way to connect with new audiences?*	Example: YouTube provides a format in which content can be shared easily with audiences outside the institution, either at random or by conscious selection.
Problem / Data	*Does the technology provide a source of real world data and/or problems?*	Example: Wikipedia contains ‘real world’ articles on many topics, but also contains discussions about those topics which summarise issues, so can be a valuable source of topical debate.
Collaboration	*Does the technology provide the opportunity to co-create with others?*	Example: Google Drive is inherently built to be collaborative, and supports real-time viewing and editing between collaborators, so would score 5 stars.
Structure	*Does the technology provide structures for managing activities?*	Example: tools such as Trello are structured around tasks, milestones, deadlines - the bread-and-butter of project management - and also support automatic notification of events, so would score 5 stars.
Review	*Does the technology provide methods for commenting on previous contributions?*	Example: blogging tools such as Blogger and WordPress include the opportunity for commenting on posts, therefore providing an easy method for including review.

Table 7.10: Questions designed to highlight how the invariant characteristics of specific technologies might provide an affordance in the context of the dimensions model

Using this technique it rapidly became clear that the technologies did not easily sit under one dimension. Using the themes as outlined to guide choices, and with the dimension model from Phase 1 as the framework for alignment, various problems were identified, for example:

- Wikipedia might be used to explore real world problems and data, but due to its embedded discussion forums and support for commenting, it might also be used for collaboration and peer review.

- YouTube could be a useful place to explore new audiences, and hence challenge students to conceive new ways in which to summarise their thinking, but also has a commenting and ratings system that might provide peer review opportunities.
- Facebook has a very well developed ability to support social interaction, hence might provide support for collaboration, but also provides many tools for linking content in and across time.

Figure 7.23 demonstrates this problem in the context of the dimensions model, using the example of Blogger, showing how a specific technology could be seen to match multiple dimensions, and how it might provide stronger support for some dimensions over others.

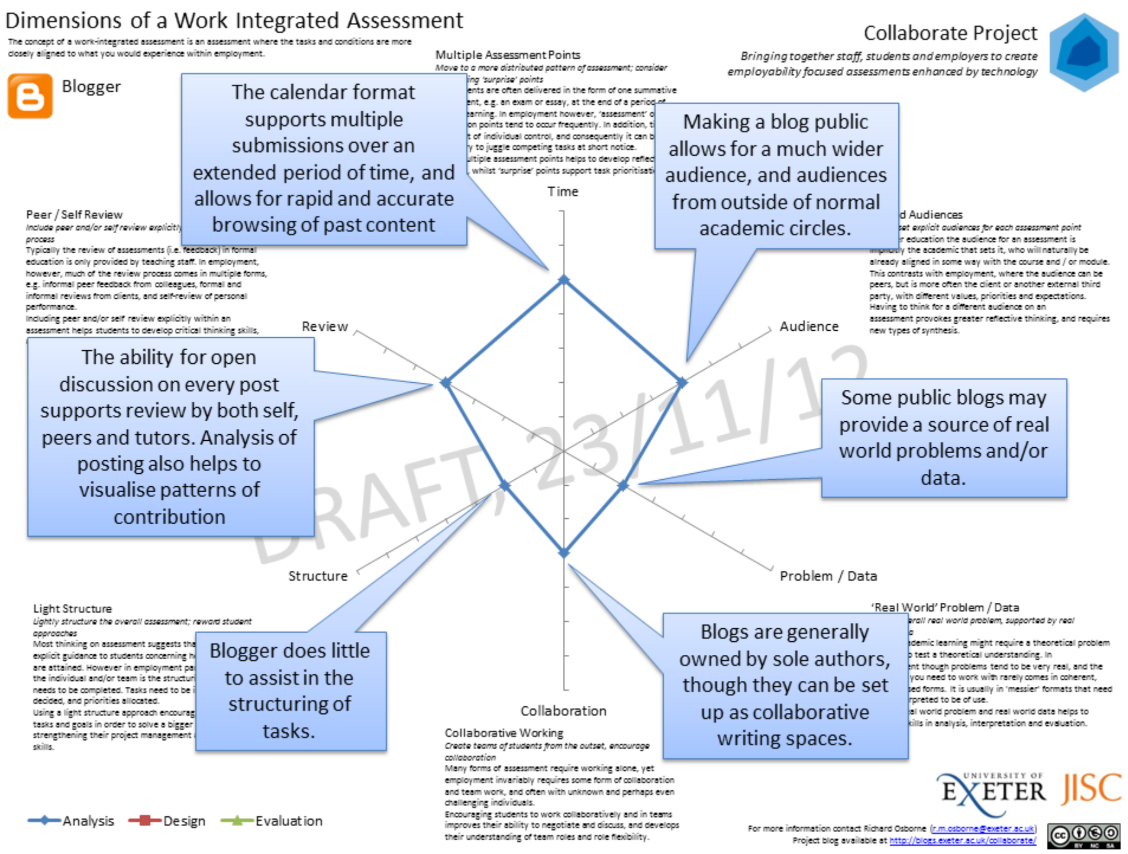


Figure 7.23: How the Blogger technology might be matched against the dimensions model

Grouping technologies under headings that try and treat all technologies as similar types with similar affordances did not seem to work. A method was needed which would identify the affordances of the selected technologies in relation to the model's six dimensions, to effectively align the pedagogy captured by the model with the affordances offered by the range of digital technologies.

Technology 'Top Trumps'

The 'Top Trumps' card game, popular in many parts of the world, seemed to offer a potential solution. 'Top Trumps' take a series of related objects, listing their strengths and weaknesses against a series of fixed measures. By adopting this top trump metaphor, and setting the measures as the six dimensions from the model to capture intention, ratings could then be assigned for each technology summarising what it "provides or furnishes" (Gibson, 1979) from an affordances perspective for each dimension in turn, effectively identifying the affordances of different technologies in context. Affordance becomes the design tool through which to align intention and invariant, to align pedagogy and technology

A dummy version that visualised this concept was produced and tested, and can be seen in Figure 7.24. This was drafted when still considering groups of technologies as opposed to individual technologies, as depicted in the star diagram, hence the label of 'podcasting'.

Figure 7.24: Initial concept of a technology type card

The star ratings summarised the affordances of the technology in relation to the dimensions. It should be noted these will be the *potential* affordances provided by each technology in relation to the model. Whether the affordance is attended to in practice will depend on the individual learners: whether they have had the opportunity to discover the affordances, either through modelling or through exploration, and whether or not they have a specific need that the technology meets, i.e. whether or not the assessment as designed using the dimensions model focuses on specific dimensions.

The next step required star ratings to be generated for all the digital technologies which were identified in Phase 2. A set of broad criteria were established to decide whether or not a specific technology should be included, and a set of guidance was written on how to rate technologies, which can be seen in full in Appendix E6. Small focus groups of staff then allocated up to 5 ‘stars’ for each of the dimensions, by asking the questions listed in Table 7.10. The purpose of these questions was to provoke thinking about how many stars a particular technology should be assigned for each dimension, in what might be understood as a dialogic approach. Creating and then asking questions made explicit how invariant properties or components of digital technological might provide an affordance when considered against the pedagogical intention suggested by the model. The questions were very specifically focused around what each technology might *provide* or *furnish* for learners, using the language of Gibson, in the context of each of the six dimensions of the model. This allowed a rating system to emerge where the invariants within the digital technologies were aligned with the pedagogical intention as captured by the dimensions model. Using this approach, the flexible manner in which the same digital technology might have value within different learning contexts was quantified.

Even though a technology may not appear to have any relevance to a dimension, the stars are designed to be assigned on a scale of 1-5, therefore every card should have at least 1 star for each category. Using this technique Blogger, for example, would score highly for Time and Review, as it uses a diary-based approach and has extensive commenting and feedback facilities. It scores lower for Collaboration and Problem/Data, however, as it has limited team-working facilities and does not inherently provide any data or real world problems.

A core aspect to this technique is that it explores technologies not as tools, but as places. Chapter 4 has explored this concept of digital technologies as providing environment, spaces and places within which teaching and learning might take place. Not as tools separate to the process of learning and only tangentially involved, but as central to the overall learning process, as a place which is constantly referred back to, revisited and reworked. The focus of the questions is not on what you can do to the technology, i.e. what actions you might be able to perform, but what the technology can do for you. The technology is given agency in itself, it has the potential to influence as well as be influenced, in what might be referred to as an ecological approach. YouTube is seen not only as a tool for storing videos, but critically as a place where videos that have been added can be viewed by others, hence opening up the opportunity to bring into learning new audiences and new perspectives. Blogger is seen not simply as a tool for writing, but as a place where writing can be reviewed by others, supporting peer approaches to learning.

By using this technique the potential affordances of each of the technologies was rated, in the context of the dimensions model, creating a set of 'Tech Trump' digital playing cards. Well over 100 Tech Trumps are now held in the collection, but as it is a live resource managed by the University of Exeter this changes regularly. However, the latest publicly available version can be found at: http://goo.gl/d4YOXk. Examples of three of these Tech Trumps are shown in Figure 7.25.

Figure 7.25: Three examples of the tech trump cards

The overall framework was designed to recommend not just one potential technology to support a pedagogic design, but multiple technologies that might be appropriate, as recommended by emergent themes from participant interviews. This design feature should allow individual students and/or academics to select specific technologies from a choice based on personal needs and experience, matching the individual and relational nature of the affordances concept.

Modelling use of technology

The tech trumps provide the alignment of technology within the overall design framework, but it was felt that simply providing descriptions on digital cards to students of potential technologies would not be enough. Some way of modelling the technologies would be necessary in order that the affordances could be made explicit, and hence be picked-up by the students. This raises the question of how affordances might be learnt.

A potential weakness of the theory of affordances is that it does not explore how affordances develop from the animals' perspective, i.e. how animals actually learn affordances (Oliver, 2005). What Goldstein calls his "failure to deal adequately with the fact that affordances must be learned" (Goldstein, 1981, p. 193). Although Gibson mentions learning several times in his discussion of affordances, he never provides a thorough explanation, instead simply stating:

> "… affordances of the environment are perceivable and are usually perceivable directly, without an excessive amount of learning."
>
> Gibson (1979, p. 143)

As Goldstein notes:

> "What is missing here is the amplification of this statement. Learning must be involved in a person's understanding of the meanings of objects, and this involvement deserves more discussion than Gibson gives it."
>
> Goldstein (1981, p. 193-4)

However Gibson does unquestionably accept that learning does need to take place:

> "If the affordances of a thing are perceived correctly, we say that it looks like what it *is*. But we must, of course, *learn* to see what things really are - for example, that the innocent-looking leaf is really a nettle or that the helpful-sounding politician is really a demagogue. And this can be very difficult."
>
> Gibson (1979, p. 142) [his emphasis]

But is the question of how do individuals actually learn affordances really a question at all? Or, perhaps more correctly, is this simply a question of how do people learn, not how do people learn affordances. That would seem perhaps to be beyond the remit for an ecological psychologist writing about perception. Perhaps with that in mind it is more the remit of the educational psychologist to try and integrate affordances theory with theories of learning, rather than to hold affordances theory to account for not being a theory of learning in itself.

From Dewey (1916) to Lave and Wenger (1991), key learning theorists have proposed that learning is both experiential and situated, that learning happens through personal experience in a real context. Given that context, affordances could be learnt through experiencing the world around us, there should be no need to postulate another special and separate method whereby affordances are somehow acquired. Social constructivist thinking suggests that should learners watch someone demonstrating or modelling a technology in real time, that should provide enough information in order to start the learning process in itself, and learners should be able to pick-up the affordances that are relevant to their specific need through this modelling. As Chapter 2 has discussed, research by Costantini and Sinigaglia (2011) appears to validate this idea in practice.

As a consequence, very short demonstration sessions were devised for the iterations, whereby digital technologies that had been aligned to the learning scenario through the design framework were modelled for students. These demonstrations were purposefully designed to be very short, 10 minutes or less, and emphasised real time use of a digital technology that could be directly observed. Provided all the elements of the design framework were in place, with intention established through the dimensions model, it was anticipated that this would be sufficient for affordances to become apparent, with the bulk of any extra learning of a specific digital technology left to the students themselves.

Evaluating impact

The final phase in the research was the development of an evaluation package to measure the impact of any intervention. The design based research approach uses multiple iterations, with results from each practical iteration undertaken used to refine and develop the next. Evaluations were designed for these iterations in order to measure the impact that use of the design framework had on students, academics and other key participants when used in practice, and also to help understand when to stop iterating, as outlined in Chapter 5, 'defining success criteria'.

Evaluations of the iterations were carried out using two types of evaluation:

- Pre-planned hour sessions with students using three specially designed physical and digital evaluation tools
- Semi-structured video interviews with specific students, academic staff, employers and other key stakeholders as appropriate

Pre-planned hour sessions with students

Student evaluation sessions were designed where students completed three evaluation exercises during one hour session, facilitated by myself.

Activity 1: 'Mark on the Line'

This was an individual activity using eight A1 sized 'mark on the line' activity sheets placed around the walls of the evaluation room, with questions about their overall thoughts on the module, and example of which is shown in Figure 7.26, and their position within the evaluation room in Figure 7.27. This was followed by an evaluator-led discussion of the collective responses.

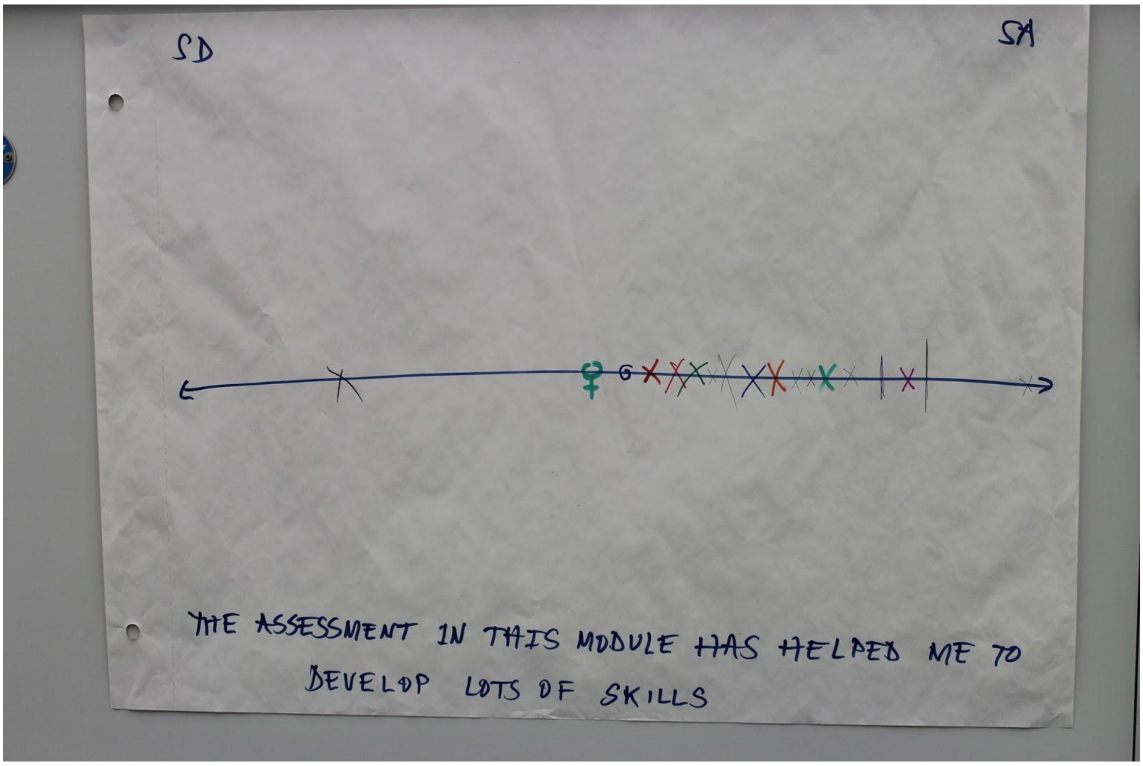


Figure 7.26: Completed 'Mark on the Line' Activity

Figure 7.27: Physical location of 'Mark on the Line' Activity sheets

Student responses on the sheets were analysed by collating them into quartiles, i.e. four sections were drawn onto the sheets to split them into four equal sections, and the number of marks in each section was then added together. These could then be displayed together on a bar chart, showing the overall cohorts responses to the evaluation questions.

The eight questions posed to the students were:

- Assessments should prepare us for the world of work
- The assessment in this module has helped me to develop lots of skills
- I understand the benefits of working in a group / team
- Employer involvement in the module is really helpful
- This module has been as I expected
- I have learnt a lot from this module
- I have really enjoyed this module

- It is appropriate for employers to be involved in assessing university work

A potential weakness of these line activities was observed in practice, in that once a mark had been made on the line it was no longer possible for another student to create a mark at the same location, potentially skewing the data. As a result, new versions of the tool were designed to use a bar rather than a line approach to mitigate against this problem. A digital version of one of these new bars is shown in Figure 7.28. Note that in this digital version, students drag an icon onto the bar to indicate their response. There is no compunction to use the same symbol on each time of the questions, icons were used here as we noted from the first iteration testing these evaluations that students tended to use a specific device, pen or colour in order to make their marks, and that this was consistent.

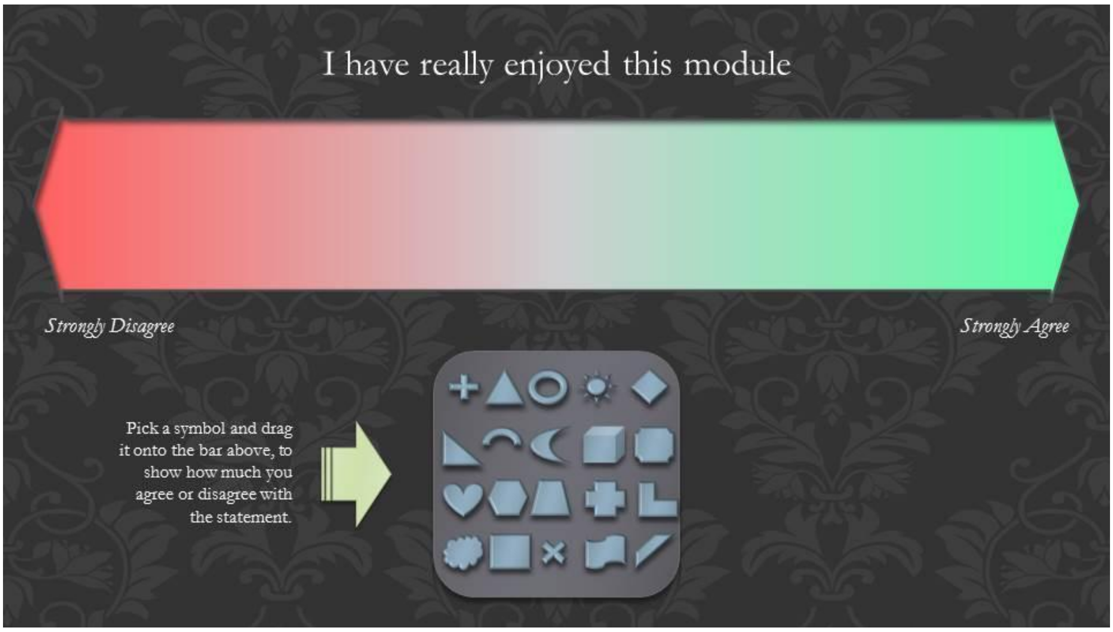


Figure 7.28: Example of the redesigned mark on the line activity sheet (digital version)

Data produced from this evaluation was analysed by marking the line into four equal sections, thus producing four quartiles within which students had annotated the line or dragged an icon to represent their response.

Activity 2: "What's the most important thing you have learnt?" postcards

Chapter 6 has discussed how the student star cards used at School A appeared effective partly due to their speed and flexibility of use. They did not, however, provide much insight into what particular students had learnt during the session. A form of evaluation was needed which could be used as quickly and flexibly as those at School A, but at the same time could provide deeper insight into what it was the students actually felt they had learned. The School A cards provided the spark for a new evaluation idea, personal postcards from the learners to the researcher.

The postcard format is well known, so would not appear unusual or unnatural for the learners. It is also a well-known format for sending a message from one individual to another. It is also constrained, in that only a limited amount of text is possible within a postcard. Finally, it is something that is designed to be used quickly and simply.

Instead of a quantitative response of the star cards, a qualitative response was now required. Students were individually required to answer the question "What's the most important thing you have learnt?" by writing on postcards specially designed for the session. These cards were designed to be a simple reflective exercise positioned in between the other two evaluation activities, and act as a reflective pause between them. Example images of the postcards are shown in Figures 7.29 and 7.30, below.

Figure 7.29: Front of the evaluation postcards

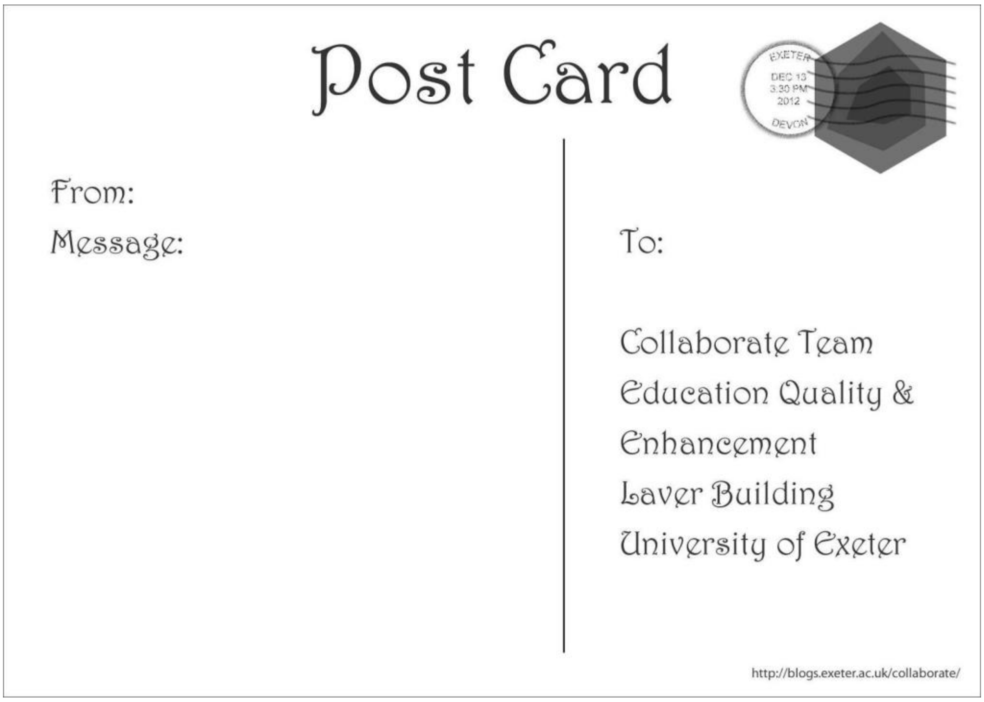


Figure 7.30: Back of the evaluation postcards

Data from this evaluation was analysed using a simple coding technique, where codes were derived directly from the data using an exhaustive process. The small area of the cards naturally restricted the amount of information that could be written, forcing students to be succinct in their feedback. This also meant that every one of their comments could be included in the evaluation data, i.e. if comments were written about teamwork, reflection and discipline specific knowledge all three of these would be added to the resulting dataset. These datasets would then be displayed on pie charts to show the overall picture of learning across the cohort as reported by students themselves.

Activity 3: Drag and drop skills evaluation

When the dimension model was first used in its new radar format, and the two initial cycles of first analysis and then the redesign of an assessment were conceived, it became obvious that there was the possibility at least of adding a third polygon to the chart - one that would summarise how well an intervention had met its overall objectives. The question was how could this be achieved in practice. How could the individual experiences of students who had experienced a redesigned assessment be summarised against each of the six dimensions.

The notion of skills development provided a possible solution. Skills development had been repeatedly discussed by interviewees, and references to explicit skills had become embedded in dimension descriptions, for example the ability to articulate and evidence, to synthesise, to interpret data, to negotiate and discuss, etc. These skills that arose through stakeholder interviews were blended with a list derived from Bennett et al (2000), which can be seen in Table 7.11, and used to provide a framework for a skills evaluation drag and drop exercise.

MANAGEMENT OF SELF	MANAGEMENT OF INFORMATION
● Manage time effectively ● Set objectives, priorities and standards ● Take responsibility for own learning ● Listen actively and with purpose ● Use a range of academic skills	● Use appropriate sources of information (library, retrieval ● systems, people, and so on) ● Use appropriate technology, including IT ● Use appropriate media

(analysis, synthesis, argument, and so on) ● Develop and adapt learning strategies ● Show Intellectual flexibility • Use learning in new or different situations ● Plan/work towards long-term aims and goals ● Purposefully reflect on own learning ● Clarify with criticism constructively ● Cope with stress	● Handle large amounts of information/data effectively ● Use appropriate language and form in a range of activities ● Interpret a variety of information forms ● Present information/ideas competently (orally, in written form, visually) ● Respond to different purposes/contexts/audiences ● Use information critically ● Use information in innovative and creative ways
MANAGEMENT OF OTHERS	MANAGEMENT OF TASK
● Carry out agreed tasks ● Respect the views and values of others ● Work productively in a cooperative context ● Adapt to the needs of the group ● Defend/justify views or actions ● Take initiative and lead others ● Delegate and stand back ● Negotiate ● Offer constructive criticism ● Take the role of chairperson ● Learn in a collaborative context ● Assist/support others in learning	● Identify key features ● Conceptualize issues ● Set and maintain priorities ● Identify strategic options ● Plan/implement a course of action ● Organize subtasks ● Use and develop appropriate strategies ● Assess outcomes

Table 7.11: Skills list (from Bennett et al, 2000, p. 31)

The skills were modified slightly in order to align them with the six dimensions of the model. The alignment between skills and model, i.e. the way each skill was matched against a different dimension, can be seen in Appendix E7. This then provided a way of evaluating skill development against the specified pedagogical intention captured in the dimensions model.

Using PowerPoint, but in a non-traditional manner, a master template was created which created a framework within which to rate skills using a simple Likert-type scale. Skills themselves were set out on individual digital playing cards, and stacked in a digital pile opposite a selection of 5 possible placeholders for each to be dragged to. This arrangement can be seen in Figure 7.31.

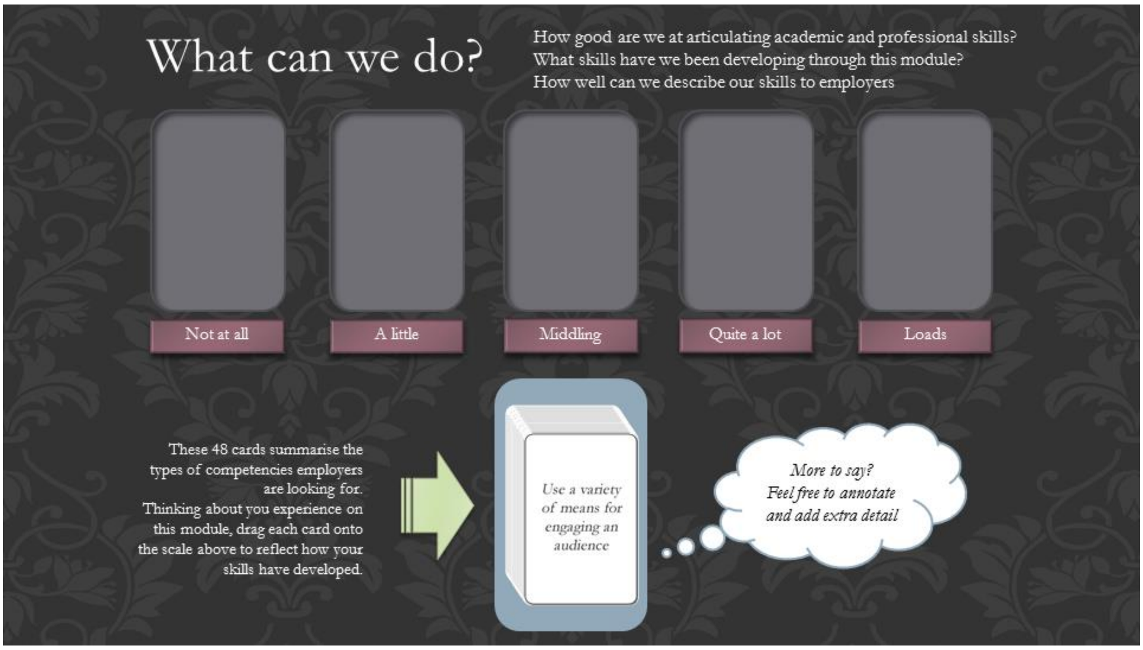


Figure 7.31: Digital skill cards drag and drop exercise

This was intended to be a group activity where students had the opportunity to rate how much they had developed these skills during an intervention, using a simple drag and drop activity on interactive computer surface tables. These snooker table sized computers allow groups of students to interact with digital content simultaneously, much like a very large iPad. An image showing these in use is shown below in Figure 7.32. A video of the drag and drop evaluation is also available online at https://www.youtube.com/watch?v=AGBYp0Z72P4.

Figure 7.32: Drag and drop evaluations

The surface tables were chosen specifically because of their ability to support group interaction. Higgins et al (2012a) has suggested that features of multi-touch tables can support collaborative interaction more effectively than paper based equivalents. Although their work was focused on supporting learning as opposed to evaluation, what seemed to emerge from their research was a deeper and richer interaction as a result of using this type of technology to support discussion, “more effective joint understanding” (Higgins et al, 2012a, p. 12). By using the tables a more realistic picture of group skills development should therefore hopefully emerge.

This activity was designed so that the ratings could later be analysed and compared to the dimensions model, giving an overall picture of skills development against each of the six dimensions. The activity was also an opportunity for students to reflect together on the skills and competencies that they had been developing over their module. Each dimension was measured through 8 skill cards, and each skill card had five potential slots, therefore each dimension had a potential maximum ‘score’ of 40 points per group. All the groups were added together, and this gave a sum total across the cohort. An evaluation marking sheet was designed to simplify this process, which is included in

Appendix E8.

The dimensions model has no explicit numbers associated with it, but does have seven tick marks which do create an implicit scale. Results from the skills drag and drop where therefore scaled up to seven to create a comparative picture with the analysis and design phases. Later versions of this evaluation tool were expanded to a seven point Likert type scale, to better match the seven tick marks on the dimensions model.

Physical copies of this evaluation technique were also produced, as the surface table or similar technologies are not always available. This took the form of ordinary playing cards and large A2 sized canvas mats which served as the placeholder for the cards. Image of these physical evaluation tools are shown in Figure 7.33 and Figure 7.34. Note that this version shows the increased number of placeholders, from five to seven, in order to more closely match the number of tick marks on the dimensions model.

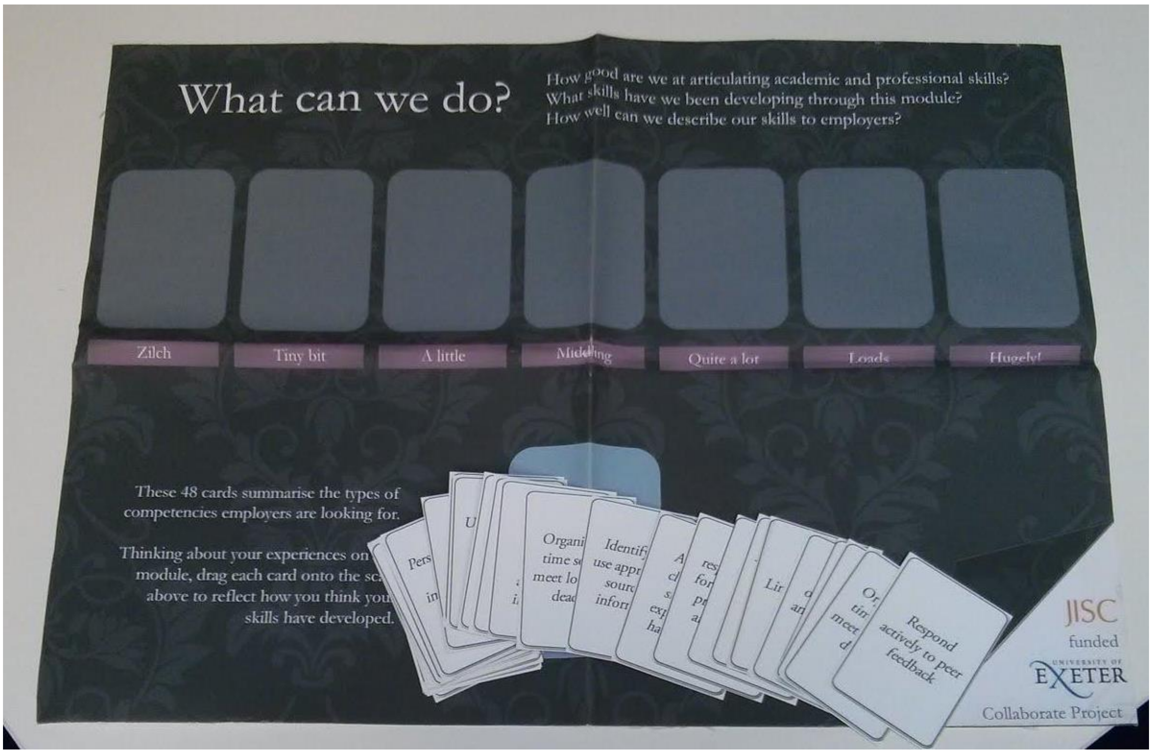


Figure 7.33: Physical skill cards drag and drop exercise

Figure 7.34: Physical skill cards drag and drop exercise (reverse of cards)

There is an inherent weakness in this approach, in that the resulting data from this evaluation exercise can be plotted on the dimensions model described earlier in the same way that a designed assessment can be plotted out, but the two data sets are not collected in the same way and therefore should not be considered to be directly related. The overall *shape* of the resultant polygon should however relate to the way in which skills were developed, just as the overall shape of a designed polygon should represent the pedagogical intention of a redesigned assessment.

Semi-structured video interviews

In addition to the formal evaluation sessions run with students, semi-structured video interviews were carried out with key stakeholders in iterations in order to gather a deeper understanding of the impact that each iteration had on these stakeholders. The questions for these interviews, grouped according to stakeholders, are included in Appendix E10. Detailed analysis of these interviews for different iterations is included in the next section, Outcomes and Analysis.

Outcomes and analysis

A key component of the design-based research approach is the use of iterations (Wang and Hannafin, 2005; Anderson and Shattuck, 2012), which can be large scale and often pseudo-experimental in form. Rather than having a predefined set of iterations to work through, the present research has taken more of a systematic iterative development approach, that “takes the tools through successive rounds of trialling and revision in increasingly realistic circumstances” (Burkhardt, 2006, p. 124), specifically using a proliferation of micro cycles (Figure 7.5, p. 248) to inform the core of the design process, developing tools and techniques across many months of testing and development. Burkhardt suggests that this approach tends to scale up gradually, with trials becoming increasingly formalised:

> “It is systematic development that turns drafts into robust and effective products. It involves successive rounds of trials, with rich and detailed feedback, in increasingly realistic circumstances.”
>
> Burkhardt (2006, p. 136)

Much of the research discussed so far has only covered the micro iterations that produced the design framework which formed the heart of the overall research, the alignment of intention and invariant through the ‘space of possibilities’ of affordance, explaining how this was developed in partnership with real academics in real contexts. In addition to this work at the micro iterations level, seventeen potential macro iterations were discussed with academic colleagues which would actively change existing assessments using the design framework, impacting real students in real contexts. A wide range of disciplines were involved, including Management, Engineering, Mining, Computer Science, History, Spanish, Psychology, Geography, Politics, Social Sciences, Law, Biosciences and the Flexible Combined Honours (FCH) programme. The level of practical engagement with these seventeen modules and assessments varied. In practice many stakeholders focused on only one aspect of the design framework. For example, for some plans went no further than using the dimensions model to analyse and define a new assessment, a selection of which have been included in Appendix E5. Most of these dimension models were left as hand annotated A3 sheets, though in some cases 'neater' versions were created using Microsoft PowerPoint so that they could be shared with colleagues and used as the basis for future discussions. Examples of these are shown in Figure 7.35 and Figure 7.36, below.

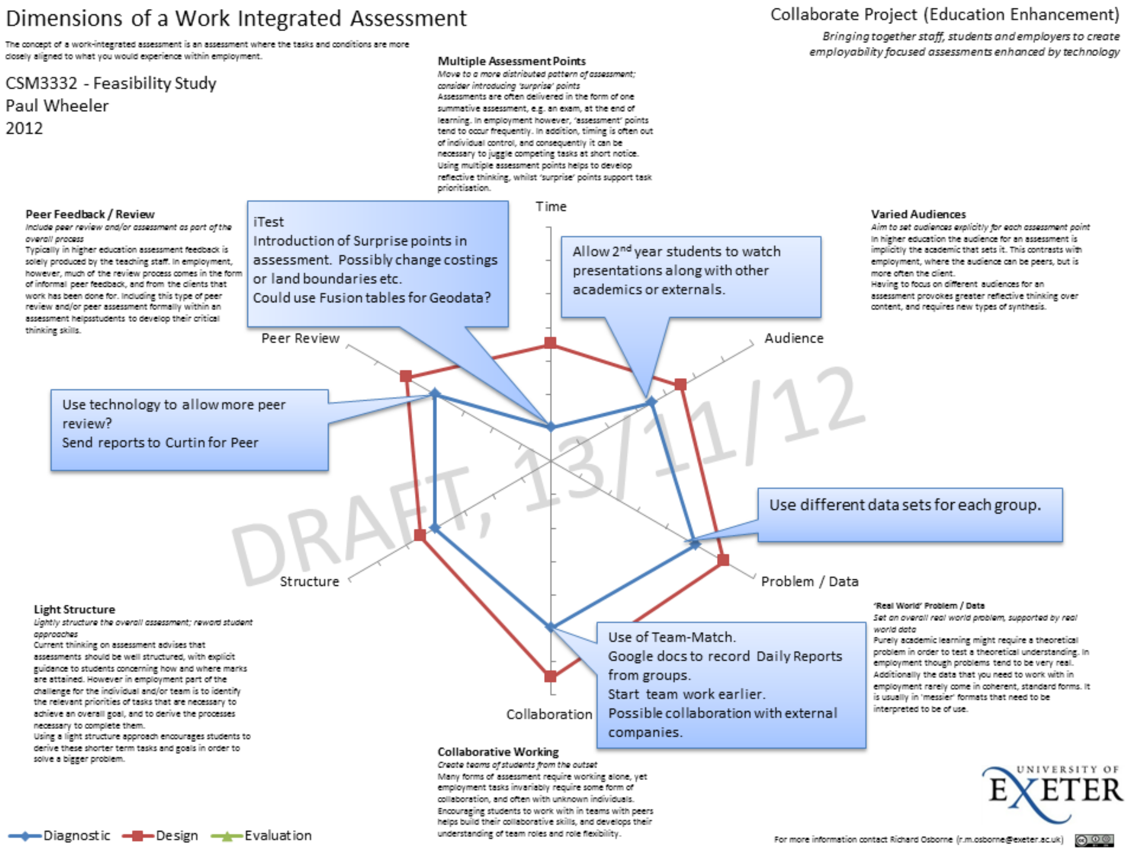


Figure 7.35: Annotated model used to summarise and share thinking (Mining)

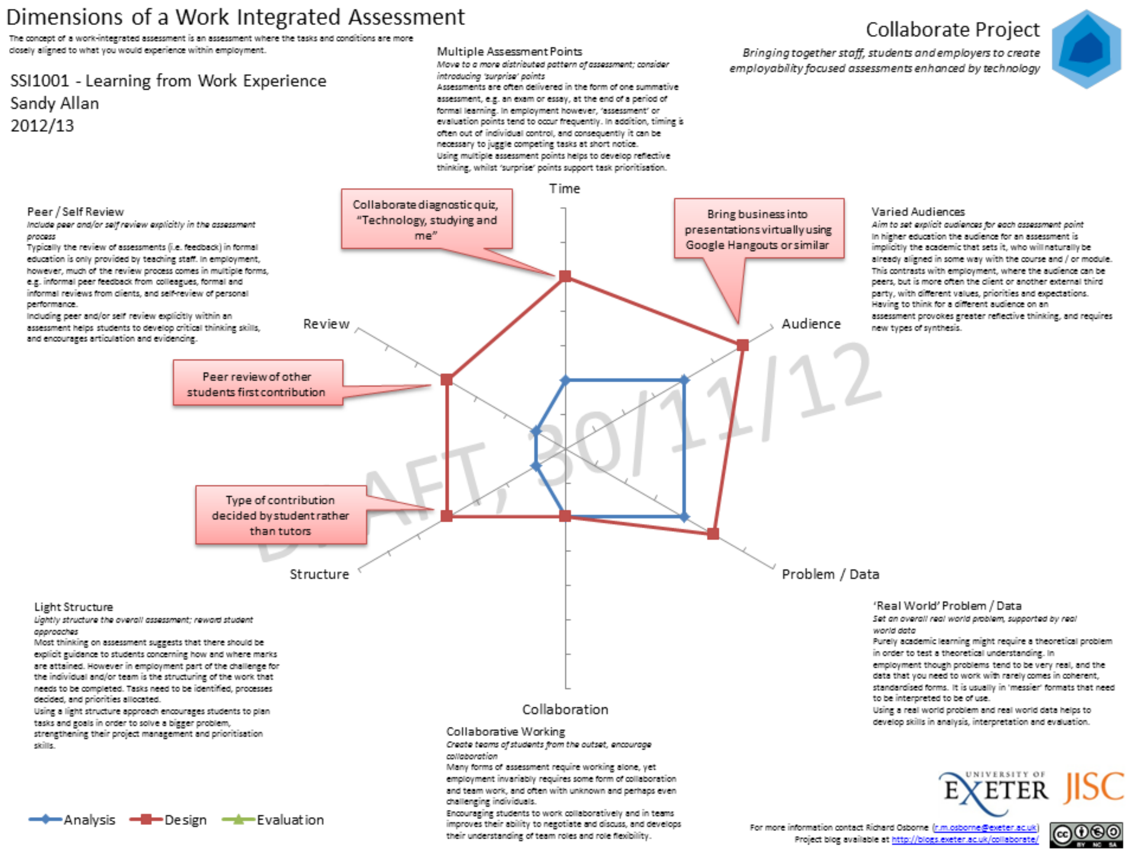


Figure 7.36: Annotated model used to summarise and share thinking (Social Sciences)

Some participants had a need to evaluate skills across time, and hence could see the value of using the drag and drop skills evaluation exercise independently of other tools. Others felt that the tech trump cards were a powerful tool to be used independently of any assessment redesign, simply as a way of highlighting the potential affordances of a range of digital technologies using the six dimensions by themselves. For some a full set of analysis, design, implementation and evaluation was completed.

This last section discusses outcomes from four of the iterations which had some of the richest and most detailed feedback, focusing on the pedagogical intention that was captured in each case, and how that was aligned with digital technologies that had the potential to support that intention. This provides a meta-analysis of the effectiveness of the design framework when used in practice.

Aligning Collaboration, Review and Time (GEOM150)

Context

This iteration took place with a geography module, “Social Enterprise, Environment and Sustainability I (GEOM150)”. This was a first year postgraduate module with the Geography department of the College of Life and Environmental Sciences. Its aim is to introduce students to social enterprise, and its role in relation to the environment and sustainability. The module allows students to apply academic learning in a real world context and introduces them to the world of consultancy, business and social enterprise. This intervention took place during the 2012/13 running of the module, with 15 students.

Intervention design and implementation

The original assessment for this module comprised a group report / business plan and a group presentation based on that report. The dimensions model was used to prompt thinking about this assessment, and the annotated model is shown in Figure 7.37, below. The original assessment can be seen at the centre of the model.

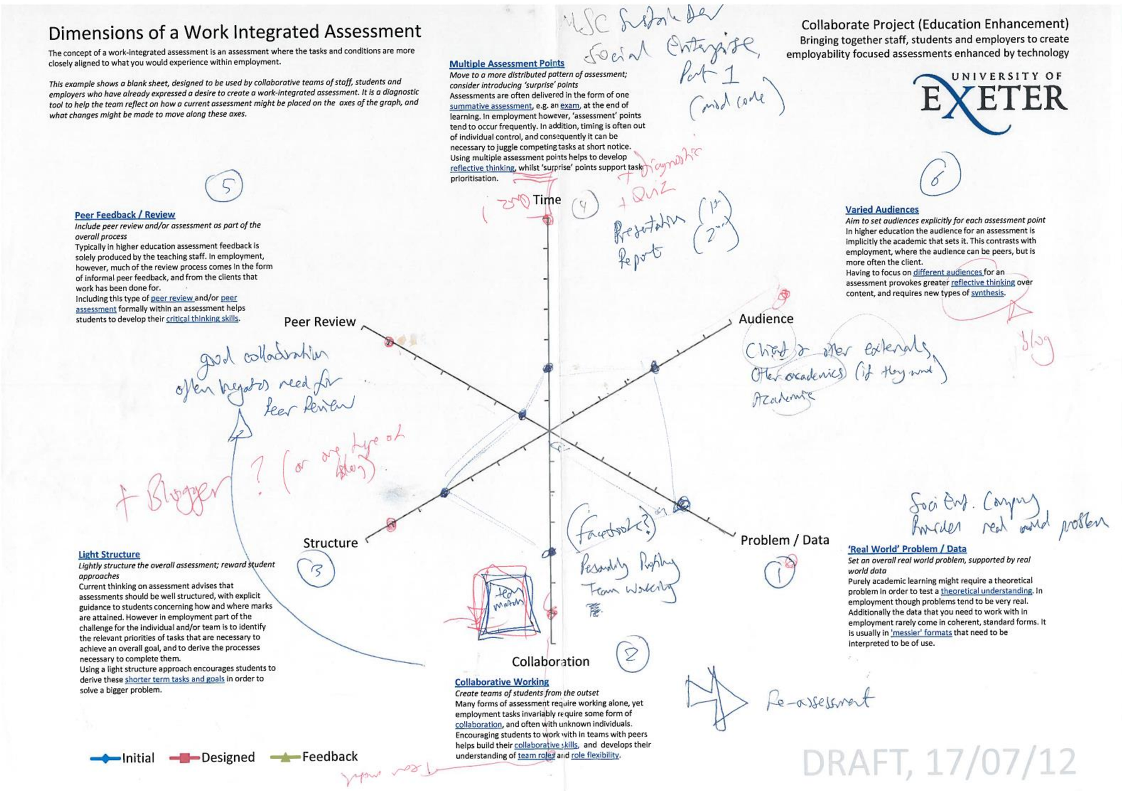


Figure 7.37: Completed dimensions for GEOM150

Changes to the assessment were discussed in order to move along each of the dimensions, which prompted the following design decisions:

- Problem/Data: Real social enterprise companies would be approached in order to provide a real world problem
- Time: More assessment points would be introduced across the module, by adding both a regular blog and a self-reflective log alongside the existing assessments
- Audience: Real social enterprise companies would be invited to presentations by the students
- Collaboration: Students would work in assigned teams of five
- Review: Peer feedback would be given for presentations, self-review would be encouraged through use of the blog and reflective log
- Structure: Blogs would provide light structure for regular postings of experiences

The redesigned assessment is shown nearer the edges of the model in Figure 7.37, with some annotation which was a product of discussions. Note that the model only shows a summary of thinking at the time. The redesigned assessment proposed adding a Self-reflective log (20%) and a Blog (20%) together with the existing Presentation (20%) and Group Report (40%).

Technologies were then identified with affordances that might support this assessment. Of the six dimensions being considered, it was felt that those of collaboration, review and time were most important to the overall task. For this reason, technologies were sought which had high star ratings and therefore strong affordances for these dimensions. Various options were discussed with the module convenor using the tech trumps to prompt thinking, and it was decided to suggest the use of Blogger, Facebook and Team-Match to support the redesigned assessment. Tech trumps for these technologies are shown in Figure 7.38.

- Blogger is a blogging website which allows individuals to create private, shared or public blogs for free
- Facebook is a social networking platform to help users digitally share aspects of their lives with friends, family and public
- Team-Match is a web application that helps create teams, analyse team strengths and weaknesses and identify problem zones.

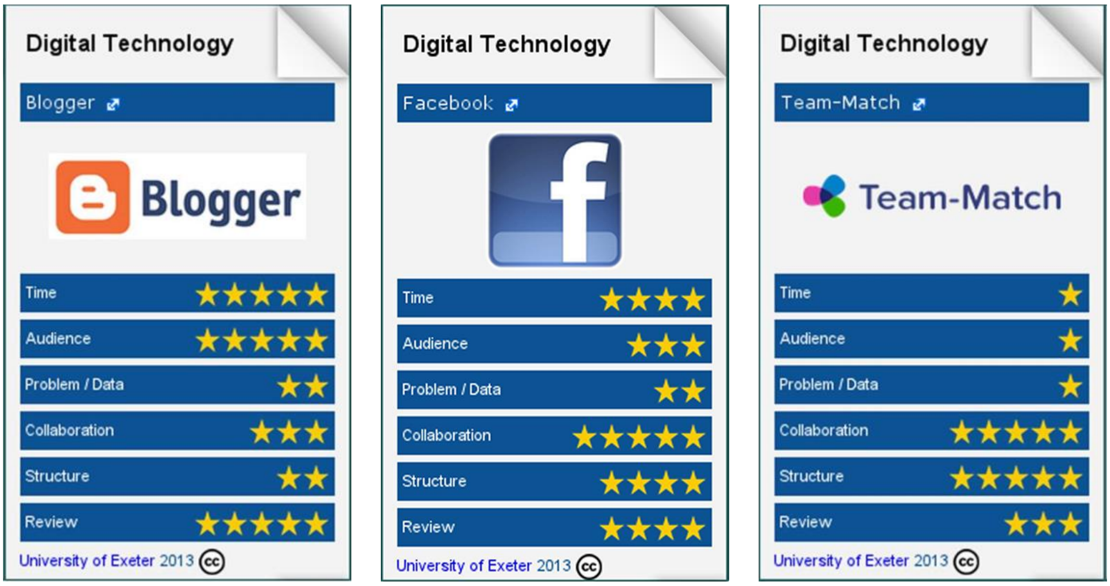


Figure 7.38: Tech trumps suggested for GEOM150

Outcomes and Analysis

This iteration took place at the Penryn campus of the University of Exeter, several hours away from the main campus at Exeter. The distance meant that much of the organisation took place through email and phone conversations. The set of student evaluation tools as outlined earlier in this chapter were not all at this stage of the research well developed enough to use for this iteration, however the skills evaluation cards and mats were available, and these were sent through to the convening academic. However, they decided not to use them as they had been intended, and although according to feedback received they were useful, no formal data was gathered.

> "I did try them out with students, and indeed their self-reflection indicated it was useful."
>
> GEOM150 Module Leader

As a consequence a new way of analysing the effectiveness of the iteration from the student perspective was required.

The students had been writing both ongoing blogs of their activities, and a self-reflective log of their experiences, and it was decided to analyse these using NVivo in order to try and identity the impact the chosen technology has on students learning. Comments that included references to the impact of technology were explored and coded. Students were working in assigned teams of 5, two of which gave themselves names: Guarda Chuva and Benyn. These names are used below to indicate which group a particular student comment originated from, along with Group 3 for the third group of students who did not name their group.

Team-Match

Analysis of the blogs and logs suggested that the Team-Match software had a significant effect on many students. It seemed to be playing three main roles: Leading to self-awareness, scaffolding personal development and supporting team role understanding.

> "Using the Team match system in class was particularly useful. It really helped to identify and understand team members' abilities and skills, and to save time."
>
> GEOM150 Student, Group 3

> "As I have been brought up in a different educational environment, I found the innovative games, group matching, team building, self-assessing tools as new and effective instrument through which one could realize his own limitations and strengths."
>
> GEOM150 Student, Group 3

Several students were initially sceptical about how valuable it might be, but rapidly saw the value it was offering both for personal development and in order to help build more effective teams.

> “In the second lecture, we were asked to use the “Team Match website”. Firstly, I did not see the point of doing this and how this could be related to Social Enterprise. However when we were asked to discuss our findings with our team members, I found it valuable.”
>
> GEOM150 Student, Guarda Chuva

> “Although my first impression of doing another group forming exercise gave me a certain feeling of disinterest, as I perceived it as a repetitive act and initially saw little learning in doing it. However, doing the personality type testing on team--match surprisingly excited me lots and spurred me to dig deeper and examine myself more extensively in the last couple weeks.”
>
> GEOM150 Student, Guarda Chuva

The fact that the Team-Match experience was impacting students not only in terms of developing the dimension of Collaboration, but also the dimension of Review, highlights the strength of the tech trumps approach, in that they do not try to pigeonhole digital technologies as having single causal effects, of being technologically deterministic. They recognise that the affordance of a digital technology in part depends on the relationship that emerges between individual and invariance within the technology. For example, some students saw more value in using the personal profile that the software creates to help them understand their own strengths and weaknesses and hence develop:

> “It was a pleasant surprise to discover that, according to Team match system, I have more strengths than weaknesses. Interestingly, it highlighted my weakness at supervising others but picked this out as strength for a team mate.”

GEOM150 Student, Group 3

Other students were more concerned with using the team profiling aspect of the software in order to help better understand which individuals from the team should be focused on which task, who should lead, who should present, etc.:

> “My reviving enthusiasm on personality type analysis made me come up with the idea to convince my group members to share our personality type profiles. My hope was that through sharing our profiles we would gain a better understanding of each other’s working styles, strengths and weaknesses and well as social roles. All this should then lead to an increased awareness among group members so we can better work along each other’s strengths and weaknesses as well as solving conflicts more subjectively and productively.”

GEOM150 Student, Guarda Chuva

It is proposed that the experience using Team-Match helped to provide a grounding in terms of self-knowledge, a starting point if you will for self-review and reflection that was continued and extended through use of a blogging format for ongoing self-reflection.

Blogger / Blogs

The original plan was to use Blogger to support the blogging and self-reflective logs, in partnership with Google Reader. The concept was that students would fill in their online diaries in individual blogs, and then share the RSS feed from these blogs with the module convenor who could then follow individual students progress automatically. In practice, however, the convenor was not comfortable using technologies that they were unfamiliar with, and hence students used a traditional technology (in this case Microsoft Word) but in a blogging style, creating posts in time defined chunks but within one specific document or place.

Students rarely if ever mentioned blogs specifically as useful in either their blogs or reflective logs, though they often reflected positively on the self-review process. The use of a typical ongoing blogging format, even without specific blog software, appeared to effectively support self-review. One student in particular used the term ‘mirror’ when explaining the effect blogging was having on them, an interesting reflection back on Chapter 6 and the work at School A, where mirroring emerged as a key affordance of the technology:

> “Writing self-reflections was a new tool for me ... I realized it as a mirror when I started writing the log.”
>
> GEOM150 Student, Group 3

Self-review appeared to be a positive experience for all students, even for those who came from backgrounds where self-review was not something they would commonly experience:

> “Writing the blog, and self-reflective log, has in itself been a challenge, as it is a method and style of writing I was previously unfamiliar with. However I see the benefit within it, and it is rather nice to be able to look back on my entries over the last few weeks, and to be reminded of the journey I have had this term.”
>
> GEOM150 Student, Benyn

> “On reflection, I have amazed myself with the amount of self-development and discovery I have been able to undertake. It is funny how my aspirations have been transformed in just a matter of months. At the start of this course, my objectives were to earn an international degree from a reputable University in the UK, have a well-paid job and be a renowned and active member of society ... I have learnt the importance of stepping back from events, reflecting and

> learning both from others and any mistakes made."
>
> GEOM150 Student, Guarda Chuva

It is possible that the technology is irrelevant to this process of learning to self-reflect, but considering that it was implicit in all their blogging and logging it would seem presumptuous to dismiss it out of hand. If, as Dewey argues, learning emerges from experiences in the environment, and in this case that environment was partly formed by a digital log and/or blog, then arguably that digital component of the environment would impact learning just as surely as anything in the real world.

Perhaps the danger is in assuming the technology is deterministic, that it will create an effect all by itself regardless of context. I would argue that from an ecological perspective what is happening is a symbiotic relationship developed between students and technology, with the blogging format scaffolding and supporting self-reflection over an extended period of time. Rather than the technology providing various actions that the students can take at specific junctures in their learning, it is providing a continuous series of transactions. It might be imagined how every time a blog is returned to, what is presented to the student first is the last thing they wrote, the digital place which is the blog contains the last thing they wrote, and hence that is the first thing they experience when they come to write something new. The student won't perhaps recognise the value that this provides to them actively, as this is a passive effect provided by the digital space that is experienced. Affordance is not emerging from the technology as a series of actions they can take, but a series of transactions, perhaps unbeknownst to the student themselves.

Facebook

Facebook was definitely used by one group of students to support collaboration.

> "After having understood that our task ... we immediately created a Facebook

> page and set weekly meetings to discuss how we would present our findings and deliver the assignment as a team."
>
> GEOM150 Student, Guarda Chuva

Although students made very few references to the software, it does appear to have become embedded in the work of this group, supporting both collaboration and review.

> "I like how well we have been using Facebook to constantly keep each other updated. We share what we have been doing and provide loads of feedback."
>
> GEOM150 Student, Guarda Chuva

> "Today we met up to discuss our presentation, which is next week. We had decided the layout of the presentation over Facebook."
>
> GEOM150 Student, Guarda Chuva

As with the other technologies, from an affordance perspective Facebook could be said to be providing a digital space for collaboration and review, extending what was possible in the real world into the digital world. The affordances that it offered were not specific actions that could be taken, but a series of transactions with simulations of one another, facilitated by the shared Facebook place. Facebook could perhaps be seen as a scaffold for group collaboration.

Video interviews

The module convenor was interviewed as described in the intervention design and implementation section of this chapter, using the questions as in Appendix E10. Data relevant to the alignment of pedagogy and technology is described below.

The dimensions model had been designed as a thinking tool to help learning designers define the learning context that they wanted to create. From a theoretical perspective, this should then help to ensure that affordances of digital technologies become more apparent given that context. The model does appear to have helped frame thinking for this iteration:

> "It has been very helpful to fit within ... the dimensions of work-integrated programme ... because I can see visually what I'm doing."
>
> GEOM150 Module Leader

It was noted that some students were nervous about presenting, and had requested that extra support was given to them earlier in the module. The notion of action versus function was discussed, in relation to the students desire to have extra guidance and support over presenting brought earlier into the module. It was noted that the use of the word 'presenting' is a very action based notion, describing what someone does to other people. There is no sense however of the effect of presenting, on why people actually present in the first place. Arguably the purpose of presenting, the intended consequence from the perspective of this thesis, is convincing others. We present because we want our audience to have an appreciation of our perspective, we want them to believe something else at the end of our presentation, to alter in some small way what they believe or think - there is an intended consequence. Students who were nervous about presenting seemed to be focused on being judged by others; in contrast students who were more confident were more focused on selling their ideas and convincing others. Arguably an action possibilities approach to affordances reinforces the more negative side to presenting, as it only focuses on doing something - not the consequences of that action.

Concerning the specific technologies chosen to support this iteration, the module convenor seemed keen to revisit Team-Match. They also expressed the desire to integrate it further with the blogging, suggesting they found it an effective way to support team collaboration and personal development through reflection.

> "I want to do Team-Match again ...each individually blog on Team-Match."
>
> GEOM150 Module Leader

> "Team-Match is very important in term one... again I need them to reflect."
>
> GEOM150 Module Leader

From a blogging perspective, they demonstrated a lack of confidence in blogging tools generally, and had received advice against using specific blogging tools from colleagues, which partly explained why blogger was not used. They were concerned that students were not demonstrating self-reflection through the blogs, something which was not born out through analysis of the blogs themselves.

Summary

This iteration focused on supporting the dimensions of collaboration, review and time. Taken as a whole, the data gathered during this iteration suggests that alignment between the pedagogical intention as defined by the dimensions model and a number of potentially supportive digital technologies had been achieved. The Team-Match software did support the collaboration dimension, and also the review dimension which suggests that it should be given a higher star rating for this category in particular, given its apparent ability to catalyse the self-review process. The use of a blog format, pushing reflection over progress back through the learning process, also seemed to be beneficial for the students, helping them to contrast past and current experience over time.

Aligning Audience, Problem/Data and Structure (MLS3049)

Context

This iteration took place with a Spanish module, "Commercial Spanish (MLS3049)".

This was a third year undergraduate module with the Modern Languages department of the College of Humanities. Its aim is to develop specific language skills linked to business on situations that take place within the business and economic world. This intervention took place during the 2012/13 running of the module, with 40 students.

Intervention design and implementation

The original assessment for the module had two major parts. In the first term the assessment comprised group work where the students create a business plan for a fictitious company based in Exeter. This involves the student adopting various roles such as Head of Marketing, Finance, Design, etc. The work culminates in a presentation of the business plan which incorporates all of this research. The assessment for the second term involved the students working independently, creating a journalistic style report on a theme of their choosing from contemporary Hispanic culture. The dossier comprises of around 15-20 articles or information sources on their theme but these may have been selected from a much larger number gathered through individual research. The articles have relevant vocabulary identified and a commentary which creates the basis for the final report on the collection of articles.

The dimensions model was used to prompt thinking about these assessments, the results of which are depicted in Figure 7.39, below.

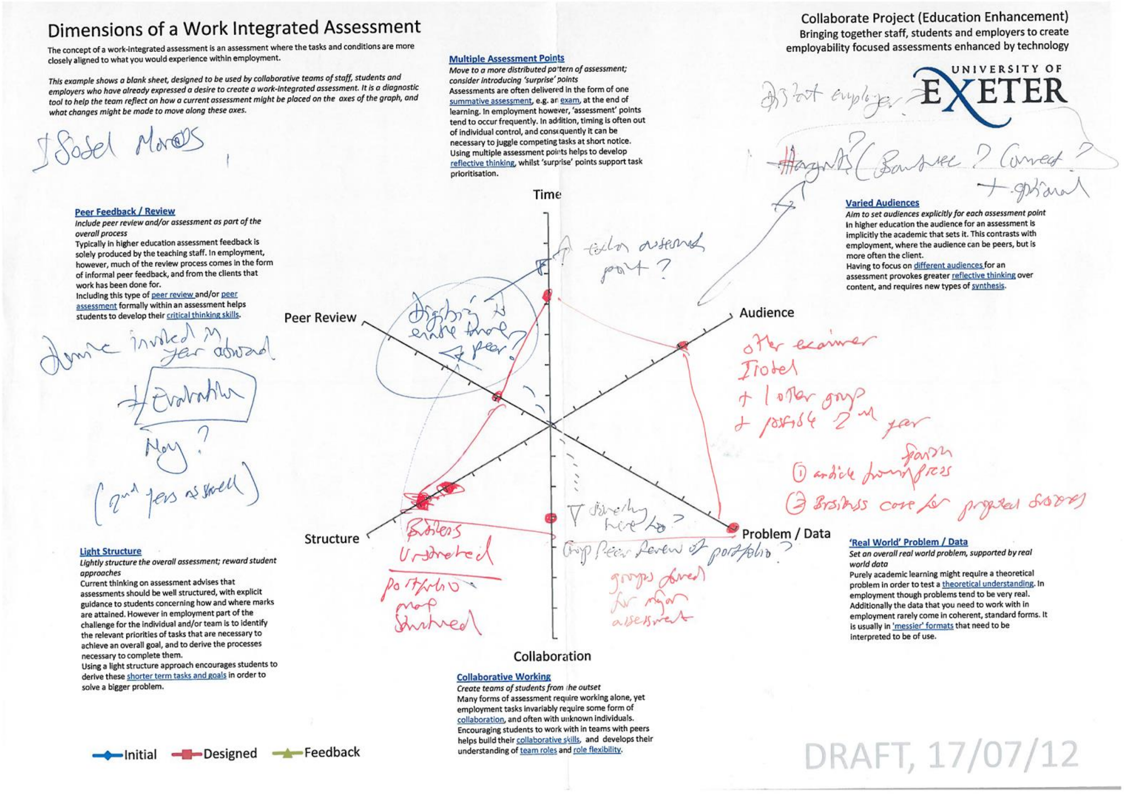


Figure 7.39: Dimensions model showing analysis and design for MLS3049

A summary of each dimension is outlined below.

- Problem/Data: The module requires the students to collect, collate, analyse and present various data sets. The first assessment utilises survey data and financial information linked to the business plan, all collected and created by the students. The dossier/report is focussed on the collection of information already in the public domain.
- Time: The two main assessment points, group project/presentation and written portfolio, are complemented by two earlier comprehension tests and multiple formative language exercises through the module, leading to the high score on Time for this module.
- Audience: The module has several elements which require the students to consider the audience for which their presentation or report is required for. The first assessment required students to carry out market research, through the use of surveys, and also via the final presentation of their business plan. The

final presentation also involves not only the tutor, but also a moderator and a group of students peers.

- Collaboration: The first assessment requires the students to work in teams, but this is the only time when collaborative working occurs.
- Review: Whilst the score here is the lowest out of all the six dimensions, this was not seen as a key area for concern. Several ways to introduce more review within the existing assessments were discussed, for example a group peer review of the dossiers or the presentations, or the recording of practice presentations for personal review, but none was in the end implemented.
- Structure: There is a high level of autonomy within the assessments, requiring students to actively create structure, leading to the relatively high score under this ‘negative’ dimension.

In this module the level of design with regards to embedding employability was seen as already rather high, hence for this iteration no specific changes to the assessments were planned. Conversations instead focused on the use of technology for supporting the students in the second assessment, the creation of a journalistic dossier, and the possible technologies to enable online submissions and marking.

The pedagogical intention as defined in the dimensions model was compared with the tech trumps in order to identify the affordances of specific technologies which might support those dimensions which seemed both key to the overall assessment, specifically the dimensions of audience, problem/data and structure. Technologies were sought which would open up potential new audiences and hence challenge thinking, and also to help students with their research, i.e. in collating and managing the large amounts of data required. Four technologies were selected from the Tech Trumps database that might have the potential to support these dimensions: Google Drive, Prezi, Scoop.it and Screenr. The Tech Trumps for these technologies are shown below, in Figure 7.40:

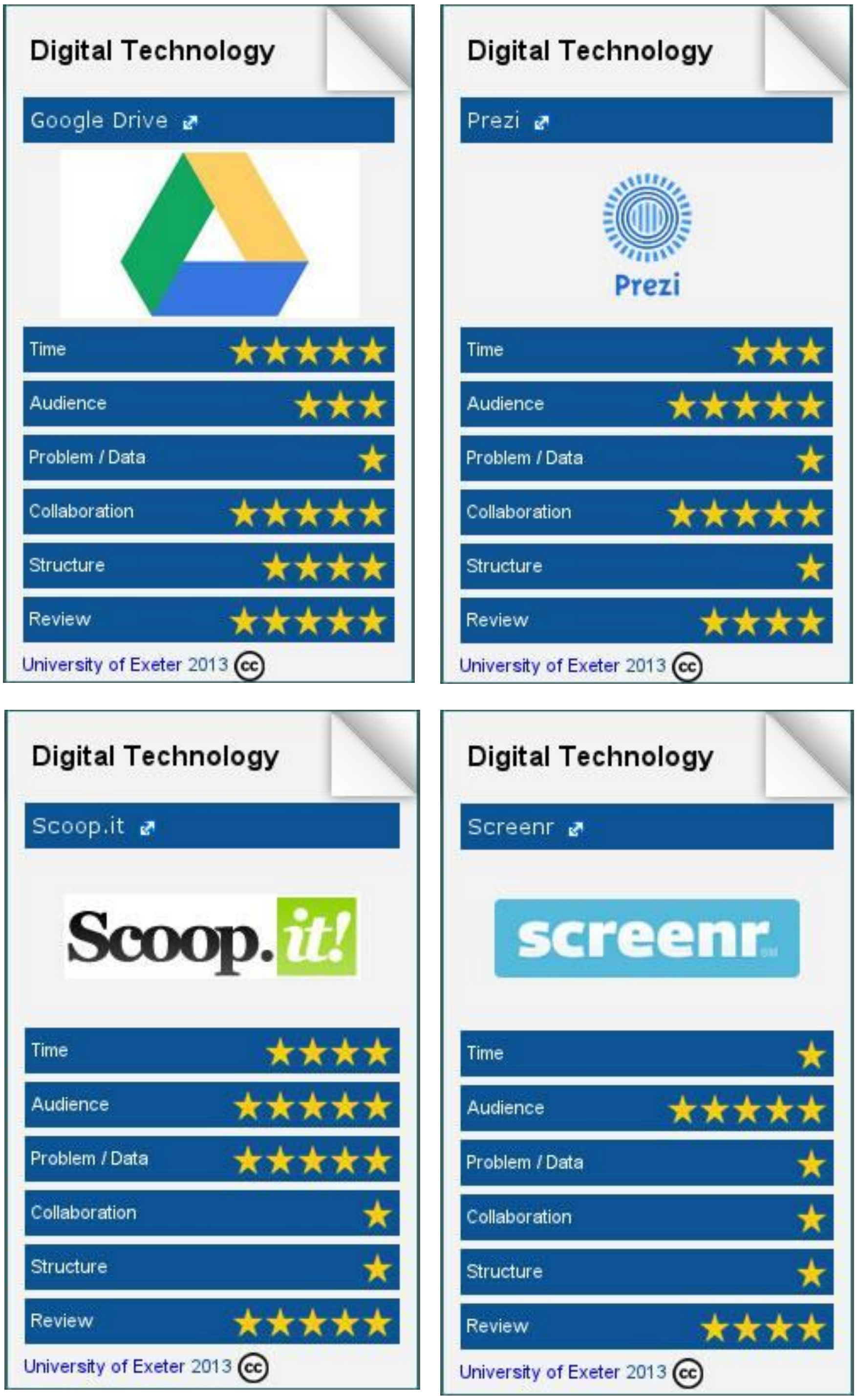


Figure 7.40: Tech trumps suggested for GEOM150

Students were given a 20 minute tutorial where these technologies were shown to them, intended to highlight the specific affordances that might be useful for the context that they found themselves within. Through the creation of a mock dossier, the students were able to see how browser plugins enabled them to use Google Drive as a file manager, where information could be stored and used to create the final dossier report, and how curation tools such as Scoop.it could allow the gathering and organising of disparate digital resources in one defined digital place. The tutorial emphasised that the technologies being showcased were not the only tools available, and that they should search for others as appropriate for their particular needs, with the Tech Trumps link supplied as a starting point.

Ways were also explored which would enable a sample group to submit via an online platform. Up to 10 of the 40 students were allowed to hand their dossier in via Turnitin, 7 volunteered. The use of Turnitin was suggested, as the tutor was looking for a way in which the large heavy dossiers could be accessed digitally, to remove the logistical problem of transporting them.

Outcomes and Analysis

Informal student feedback sessions

Several students were met with before the assessment was submitted to show them how certain technologies worked. From these 1:1 sessions it was clear that these students wanted to increase their digital literacy and start using technologies within their studies but didn't know where to start on this journey. A drop-in Turnitin surgery was also provided before the submission deadline to allow students to come and ask for assistance with the online submission process. During this time, the students who came were asked questions about their experiences with technology within the assessment task. The general consensus was that the information about what technologies could be used, such as online citation tools, is information which they wish they had received in their first year. They were unfamiliar with many of these supportive technologies as listed on the Tech Trumps.

A sample of students who also chose to submit online, were informally asked about the technologies they used to support their research and create their dossier. Reports suggested Google Drive had been very popular, along with SkyDrive. Cloud facilities were seen as advantageous, compared with previously used processes which involved USB sticks, as cloud working allowed seamless, multi destination working. The students were required to meet with the tutor a minimum of 4 times and cloud and web based facilities enabled them to show the tutor their current working simply and quickly. ‘Scoop.it’ was also heavily used and allowed in some instances for students to gain peer reviews on the articles they had chosen.

The feedback for the online submission process was also positive, with the students embracing the idea that a digital version of their work gave them new possibilities in terms of the style and types of evidence they were able to use. For example video recording could be embedded rather than having to be transcribed.

Drag and drop skills evaluation

The module convenor asked students via email to complete the drag and drop skills evaluation, however very few responded. The assessment took place at the end of a third year module, just before students left for their summer holidays, and hence it was difficult to convince students to complete the skills drag and drop evaluation. One student did respond, the results from which are shown in Figure 7.41, below:

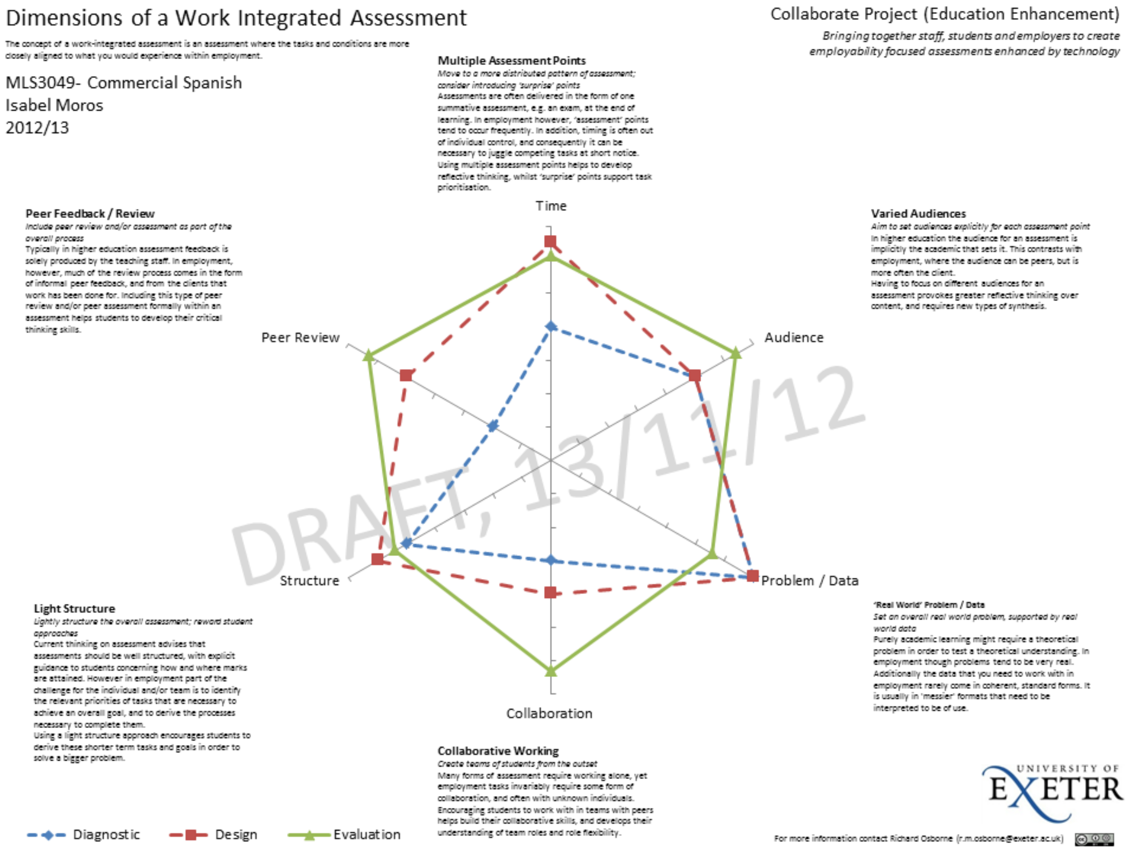


Figure 7.41: Student drag and drop skills evaluation (MLS3049)

The single student did report a well-developed set of skills through the module, including more than might perhaps be anticipated on some dimensions, notably Peer Review, Audience and Collaboration. In conversation, however, the student discussed how they were reflecting on the entire module and not just the assessments that had been specifically supported by technology, which would explain how a piece of work supposedly completed alone accounted for such high ratings for collaboration and peer review. It has already been noted by others (e.g. Mor, 2011) that Design-Based Research is intrinsically a messy business, which does not attempt to isolate and control variables, with the result that identifying how different dependents influence each other can be difficult. This might however be perceived as a strength, this student for example discussed later (see below) how they used the Scoop.it software not only to support their portfolio, but also to support their oral presentation. Once the affordances of a technology have been discovered, it seems it is that much simpler to apply them in other contexts.

Formal video interviews

The module convenor and a student from the module were both interviewed about their experiences; analysis of these interviews is discussed below.

Feedback from the module convenor was very positive.

> "I think it has had a positive impact ... first to do the research for the dossier in a less cumbersome fashion, in a more efficient manner, they have gained more control and ownership over it ... they have found their own rhythm of working ... because they were able to use the different search engines[3] that you showed us."
>
> MLS3049 Module Convenor

> "I think it was a positive outcome ... the group was quite a large group, there were 40 students, it was then easy to see those who were very familiar with new technologies, or were at least willing to take a risk, and those who were perhaps more shy about it, or were a little intimidated about it, it gave them an insight into what new technologies might mean."
>
> MLS3049 Module Convenor

Being able to have students access their work in progress via web based technologies such as Google Drive and Scoop.it was very beneficial for both the tutor and the students and it was clear to see that the use of technology had aided the students in their research task.

> "So for me, like, I put everything in Google Drive, 'cos I was finding a lot of stuff off the Internet, otherwise I would've kind of forgotten where I'd found it if I'd

[3] The academic was a little confused over the exact categorisation of the technologies being recommended, hence this somewhat odd reference to search engines

found a good article."

MLS3049 Student

Using Turnitin also proved very successful. The tutor was able to mark the previously cumbersome dossiers more effectively.

> "At the beginning I was a bit daunted about it ... once I got going I found it incredibly helpful, because it just was much easier for me to do it than to do it on paper. It enabled me to concentrate more, ermm, to get less distracted and more focused ... the freedom of adding my comments ... sharpened my ability to mark the piece in a more consistent way."

MLS3049 Module Convenor

The student noted how the shift to digital technologies had made sharing that much easier, and that then led to increased use of peer review and made it easier to share with the module convenor:

> "In our dossiers and things a lot of us sent them between each other so that we could, err, you know, double check that everyone else's was OK and it made sense."

MLS3049 Student

> "The positive element of it was that when the students came to see me to discuss their project it was easier for them to show me what they had done so far, because of using Scoop.it or Google Drive, so that was a positive."

MLS3049 Module Convenor

From an affordances perspective, it is perhaps interesting to note here again a focus not on the actions that are capable with the technology, but on the transactions that are possible. The students were interested in receiving back from each other comments and thoughts on work, and the technology facilitated this process. It extended the ability for peer review through the digital place provided by the technology. Similarly for the academic using the Grademark software, what was important were the transactions that the technology facilitated, in terms of building a library of their own thinking on feedback.

As noted earlier, once an affordance had been discovered it became easy to transfer it into other contexts:

> "I used it for my oral exam as well ... it was definitely useful 'cos you could see what you have looked at as well." [on Scoop.it]
>
> MLS3049 Student

Students also reflected how much they'd wished they had known about the type of technologies they were exposed to earlier on in their academic lives:

> "In the past it's just been Word and PowerPoint and things like that ... had I known about Google Drive before, and the fact that could have stored everything online and, you know, done it that way, I think I would have used it."
>
> MLS3049 Student

> "I had no idea about that Prezi thing ... either. I wish I'd known about that 'cos that would have been really cool."
>
> MLS3049 Student

Their lack of experience of digital technologies, and how they could be used effectively to support their learning, was echoed in the thoughts of the module convenor:

> "I think by the end of the process I definitely was much more aware. At the beginning of it I wasn't, because I think we take for granted that they are digitally capable, but that's not the case, just because they've got a smartphone or have got a tablet, it doesn't mean that they know how to make the best use of it. So that was very interesting."
>
> MLS3049 Module Convenor

Summary

This iteration focused on supporting the dimensions of audience, problem/data and structure. The use of Google Drive and Scoop.it in this context seemed particularly effective in supporting students in the gathering, analysis and synthesis of real world data, and provided a framework for the students within which to build their portfolios. In addition, the fact that these technologies used a cloud approach enabled them to be shared with both peers and academics, extending the opportunity for review through multiple audiences.

Aligning Collaboration and Structure (PSY1301)

Context

This iteration took place with a psychology module, "Professional Issues and Development (PSY1301)". This was a 1st year undergraduate module run by the Psychology department within the College of Life and Environmental Sciences. The aim of the module was to provide students with an appreciation of the key professional issues relevant to Psychological Wellbeing Practice (ethics, role and personal development, team working), including an appreciation of the ways in which a psychosocial framework can be applied to comprehend the complexity of people's health, social and occupational needs and of the range of social and health resources available through statutory and community agencies to support recovery.

Two iterations were run with this module, in consecutive years, each time with a different cohort of students and with different module convenors. This provided something of a unique opportunity to test the overall design framework in a semi-controlled way, and hence had the potential to validate the overall design, using the three ‘success criteria’ that were derived from work by Herrington (2007) as outlined in Chapter 5. These are repeated below for clarification.

- Scientific outputs: Design principles
  Principles are stable, in that further iterations do not suggest further changes to them should be made
- Practical outputs: Designed artefact(s)
  Products are stable, in that they are recognised by peers as having practical value outside of the research itself
- Societal outputs: Professional development of participants
  Participants reflect positively on their experiences within the research

By running two redesigned iterations in this way, with the same intended pedagogic design but with different teachers and learners, it should be possible to test these success criteria in practice.

The first iteration took place during the 2012/13 running of this module, with 25 students. The second iteration took place during the 2013/14 running of this module, with 42 students.

Intervention design and implementation

The original assessment for this module comprised a 75% written examination (1½ hours) and a 25% oral presentation (undertaken in pairs, 10 minutes each). The dimensions model was used to prompt thinking about this assessment, and the completed model is shown in Figure 7.42. The original assessment can be seen at the centre of the model, and does not spread out far on any of the dimensions.

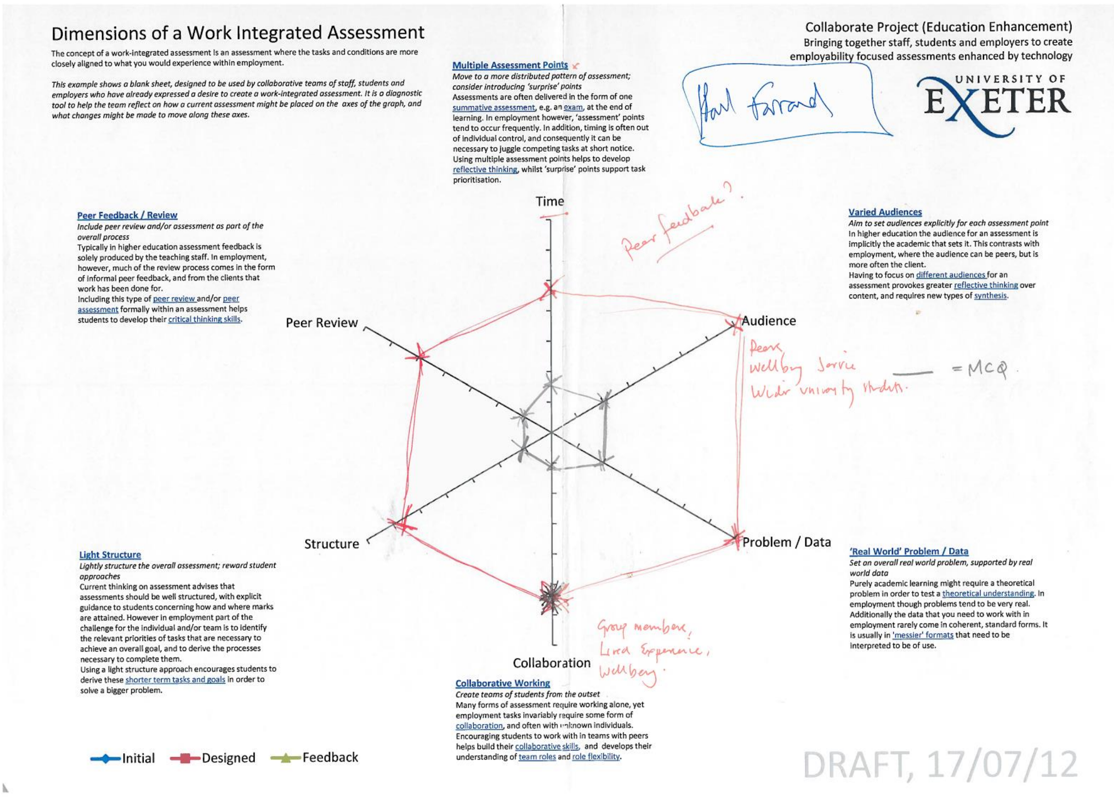


Figure 7.42: Completed dimensions for PSY1301 (2012)

Changes to the assessment were discussed in order to move along each of the dimensions, which prompted the following design decisions:

- Problem/Data: A shift from the examination to the creation of a patient information leaflet
- Time: The design and creation of the patient information leaflet would take place across the module, depending in part on the content of the lectures
- Audience: Two external groups, with links to the Psychology department, would act as new audiences for the leaflet and additional markers
- Collaboration: Students would work in assigned teams of six
- Review: Team working would encourage and develop informal review
- Structure: Detailed guidance for the creation of the patient information leaflet would not be given, instead signposts would be provided to help students find

relevant guidance independently.

The redesigned assessment is shown nearer the edges of the model in Figure 7.42, with some annotation which was a product of discussions. Note that the model does not show all the discussions that took place, just some key thinking. The redesigned assessment proposed changing to a 40% written project: 750 word patient information leaflet in groups of up to 6 students, 20% oral presentation (undertaken in groups) and a 40% MCQ test.

Technologies were then identified that might support this assessment. Of the six dimensions being considered, it was felt that those of structure and collaboration were critical to the overall task and potentially the most challenging for first year students. For this reason, technologies were sought which matched a star rating of five for both the structure and the collaboration dimensions, specifically to support students in developing skills in collaboration, team working and project management. Using this process for the 2012/13 iteration, Tech Trumps for Do, Trello and Team-Match were recommended, as shown in Figure 7.43.

- Do is a project management tool that supports work on shared or private tasks, notes, activity feeds and comments to track progress
- Trello is a project management and collaboration tool that organises projects into boards, lists and cards
- Team-Match is a web application that helps create teams, analyse team strengths and weaknesses and identify problem zones.

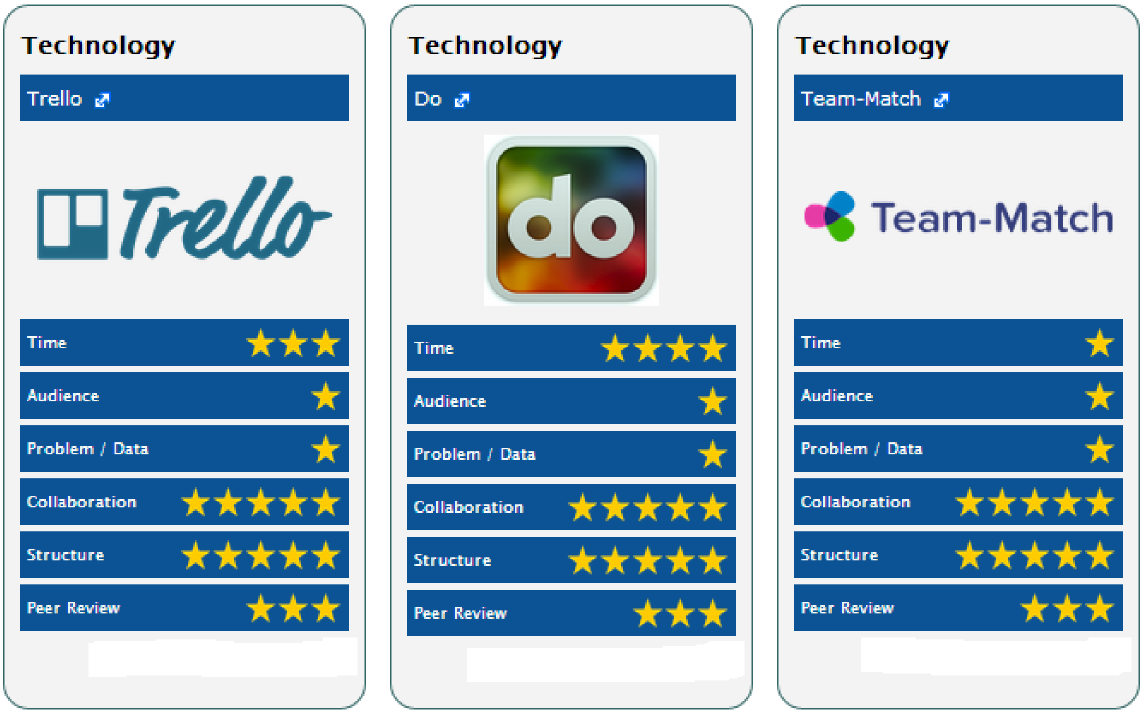


Figure 7.43: Tech trumps suggested for PSY1301 (2012/13)

This process was repeated for the 2013/14 iteration. Since the 2012/13 iteration, the do.com technology had been purchased by a third party and discontinued. Other new technologies had emerged and been added to the tech trumps database over the intervening year, and as a result Azendoo and Wunderlist were also added. Facebook was also included due to its success at supporting collaboration both in the MLS3049 module, and also in the 2012/13 iteration of PSY1301. Tech Trumps for these five technologies are shown in Figures 7.44 below.

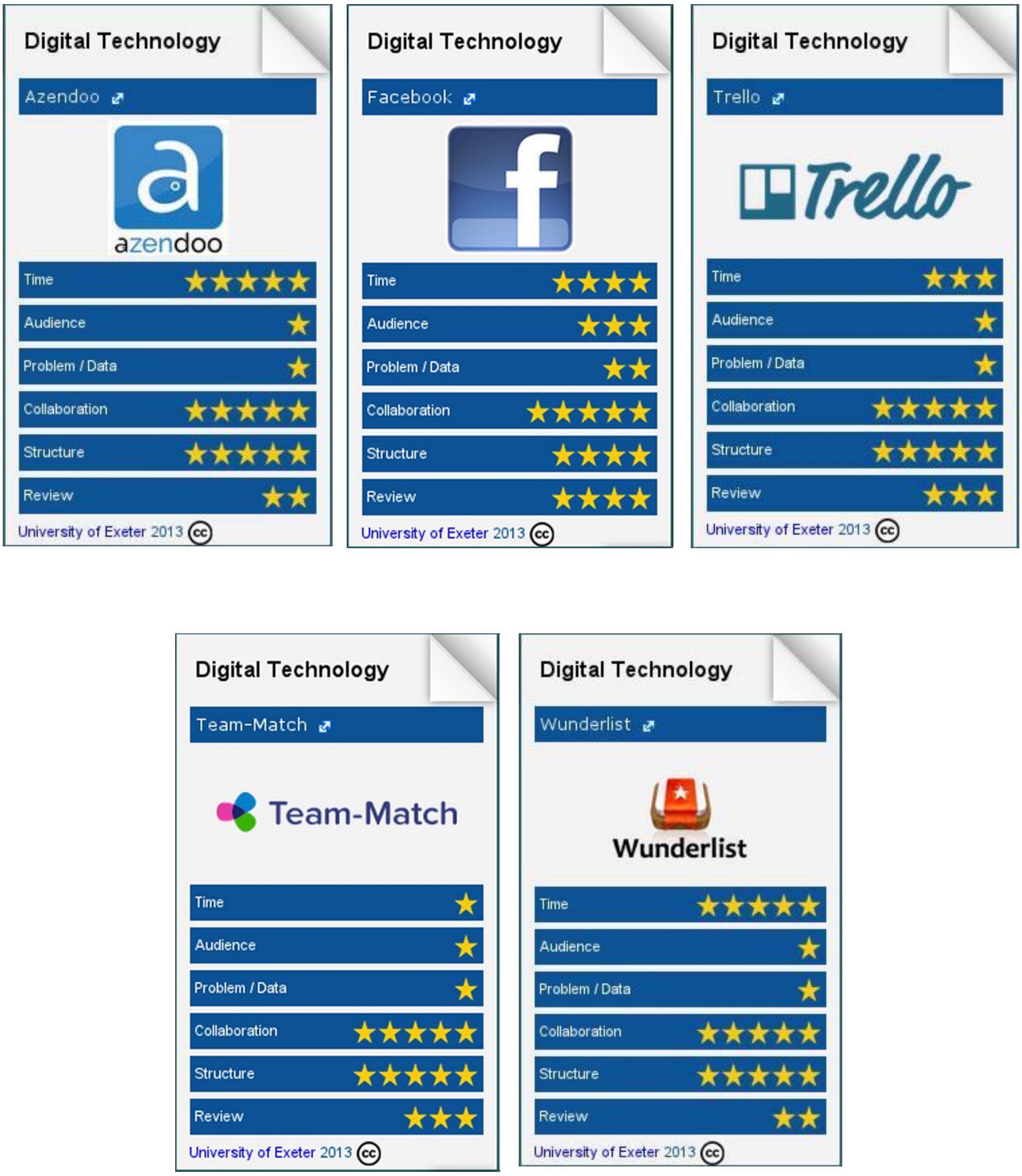


Figure 7.44: Tech trumps suggested for PSY1301 (2013/14)

Once technologies had been identified that had the potential to support the pedagogic design, the students were given 10-minute demonstrations to show how these technologies might be useful in supporting their assessment. Where appropriate a mocked-up series of tasks was used, showing how each of the technologies would deal with the various challenges that students would encounter during the module.

Outcomes and analysis

Evaluation sessions were carried out with those involved as outlined earlier in the ‘Evaluating impact’ section of this chapter. In the last week of each iteration a one hour session was organised with the students where the three evaluation tools discussed were used to gauge their experiences on the modules: The ‘Mark on the Line’ activity, Postcards and the ‘Drag and Drop Skills Evaluation’. In addition formal interviews and informal feedback sessions were carried out with both academics and students.

‘Mark on the Line’ activity

This individual activity using eight A1 sized ‘mark on the line’ activity sheets placed around the walls of the evaluation room, with questions about their overall thoughts on the module. This was followed by an evaluator-led discussion of the collective responses. Data was analysed by allocating into quartiles: the results for the two iterations can be seen in Figure 7.45 and Figure 7.46, below.

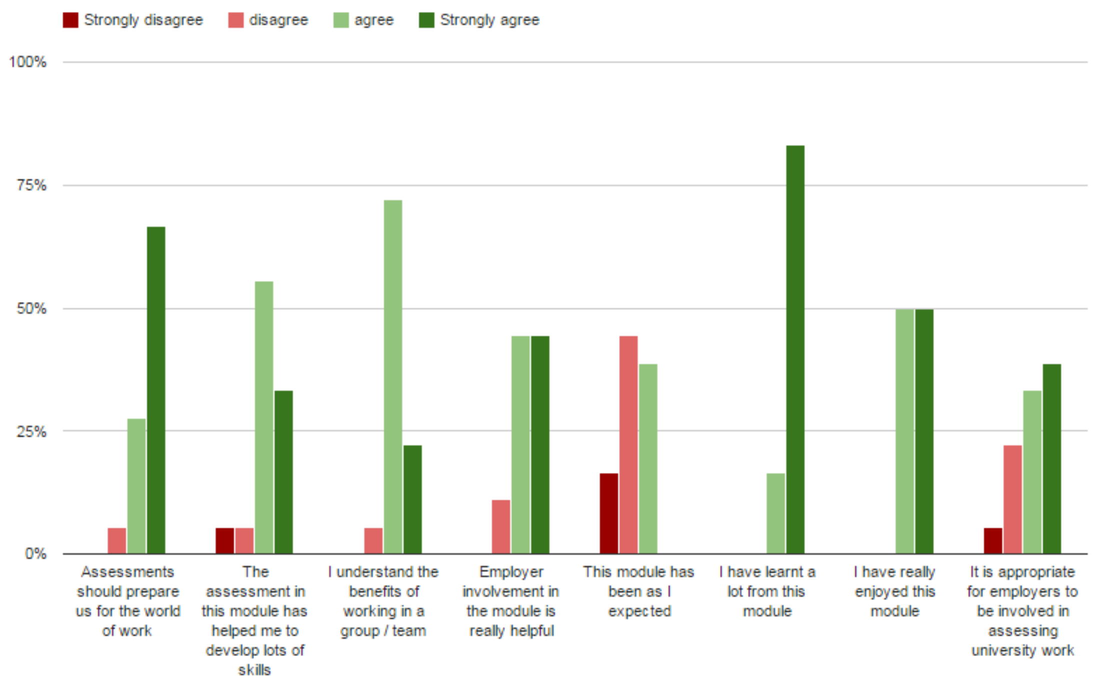


Figure 7.45: ‘Mark on the line’ evaluation data (2012/13)

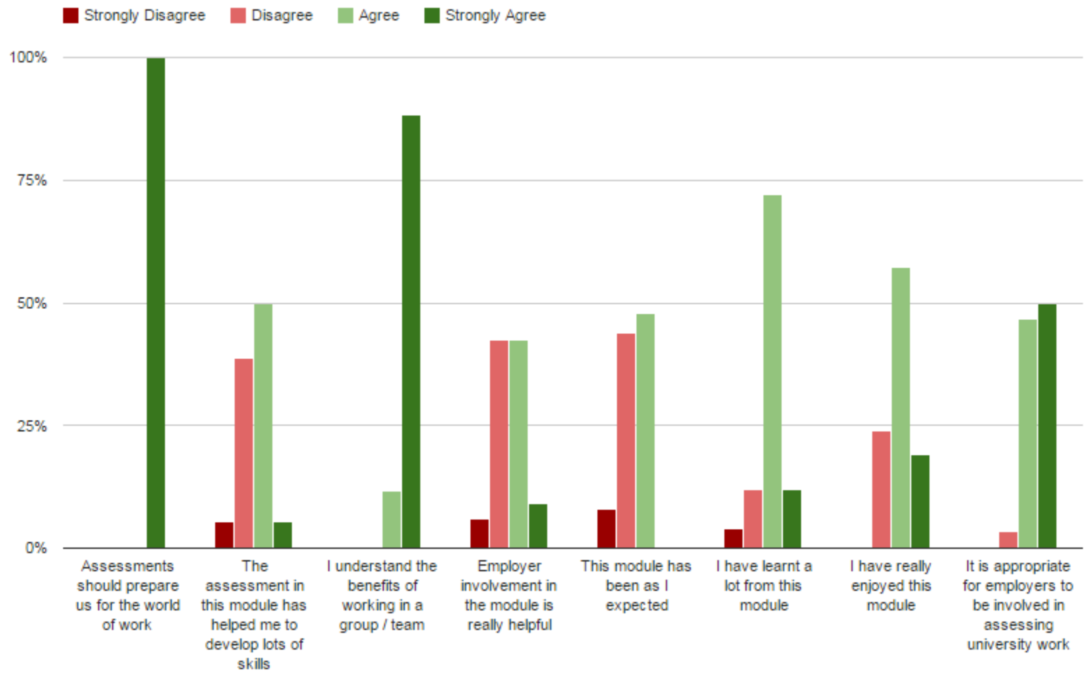


Figure 7.46: 'Mark on the line' evaluation data (2013/14)

Data from this evaluation tool suggests that the redesigned assessment had a positive impact overall on the student experience. Although students commented that the module design was unexpected, data showed that they enjoyed the module nevertheless, and they appear to have developed their skills as had been intended through the design. The results for the question "I understand the benefits of working in a group / team" in particular stood out as the most positive aspect of the module according to this evaluation, suggesting that the overall design had been effective in developing skills in team working and collaboration.

Postcards

An individual activity where students answered the question "What's the most important thing you have learnt?" by writing on postcards designed for the session. Results were analysed using a simple coding technique, where codes were derived directly from the data using an exhaustive process. This was feasible because of the limited amount of text allowed for by the postcard format. An example completed postcard is shown in Figure 7.47, below.

Figure 7.47: A completed postcard

A simple spreadsheet was prepared, with individual postcards listed on the left and keywords added as columns as and when they were observed within the data, creating a growing grid or matrix referencing the number of times a specific keyword or code was referred to. Codes were extracted by looking for common themes, for example, a postcard where the student had answered “The most important thing that I have learnt is what my most effective role in a team is” was coded as “Effective Collaboration”.

The results from this evaluation for both iterations are visualised in Figure 7.48 and Figure 7.49, below.

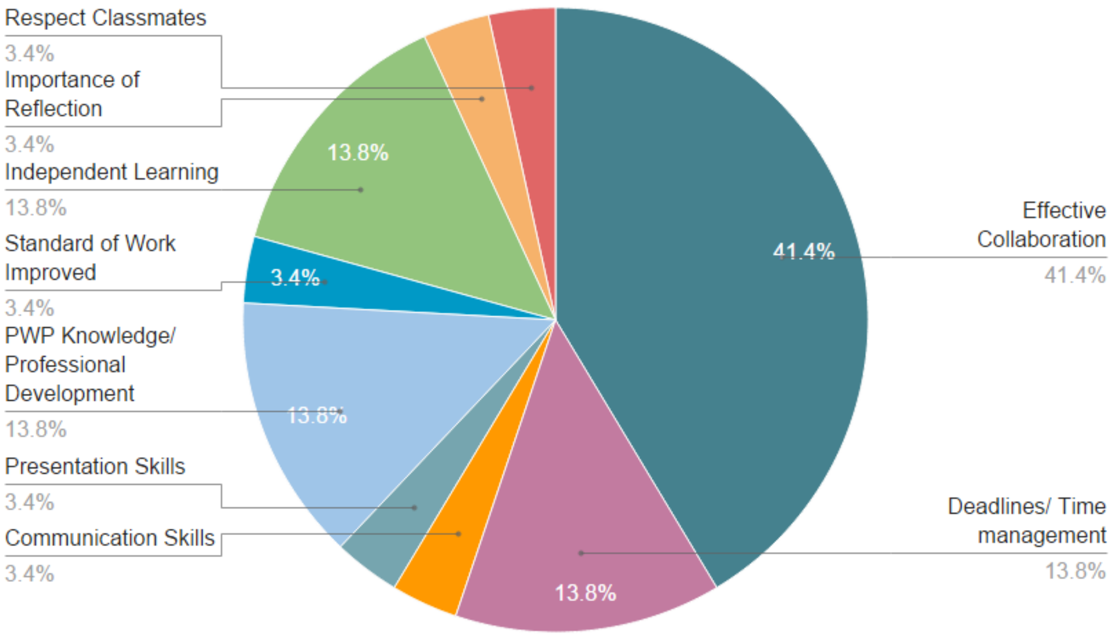


Figure 7.48: "What's the most important thing I have learnt" postcard evaluation data (2012/13)

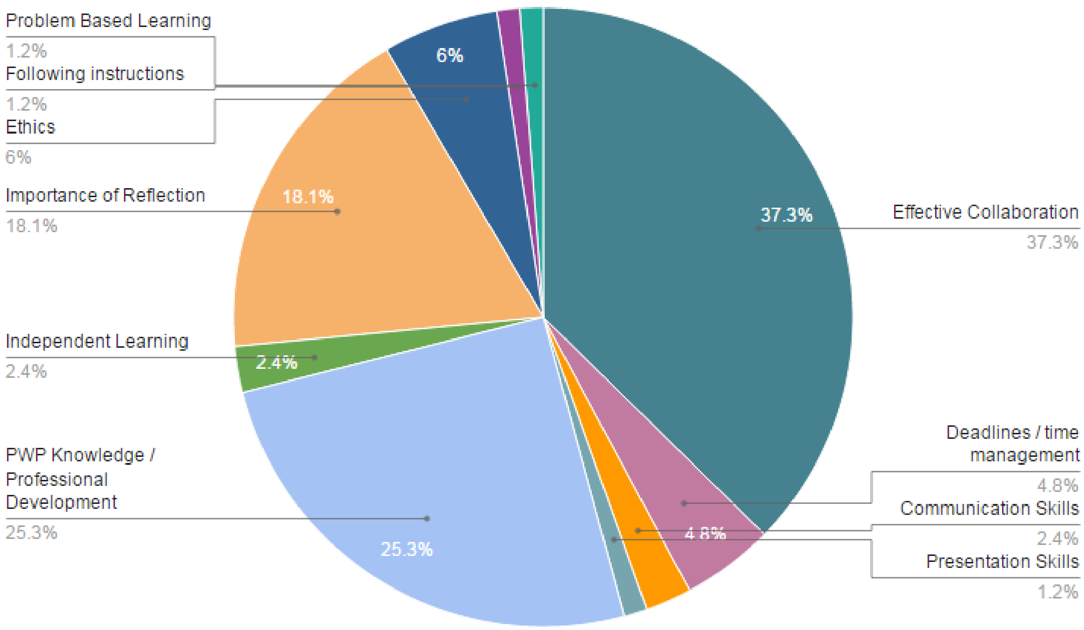


Figure 7.49: "What's the most important thing I have learnt" postcard evaluation data (2013/14)

The most striking finding from this evaluation was the degree to which students felt they had developed their collaboration skills. As in the Mark on the Line activity, students appeared to have significantly developed their team working and collaboration skills as a result of their experiences during the redesigned assessment. In the 2012/13 iteration the data suggests the students had also developed according to the Structure dimensions, in that they had emphasised through the cards how much they had developed their skills in independent learning and deadline and time management. This was not so prevalent in the 2013/14 iteration, instead students indicated how much they had developed their ability to be reflective, and to a certain extent the importance of an ethics in the workplace. Both cohorts indicated that they had developed a deeper awareness of the what it mean to be a psychological wellbeing practitioner (PWP) in practice, an identified position within the NHS, and a key aim of the overall module.

Drag and drop skills evaluation

The final evaluation was a group activity where students had the opportunity to rate how much they had developed their skills during the module, using a simple drag and drop activity on interactive computer surface tables. These snooker table sized computers allow groups of students to interact with digital content simultaneously, much like a very large iPad.

Results for this evaluation are displayed on combined dimensions models for the iterations, shown in Figure 7.50 and Figure 7.51 as the solid lines.

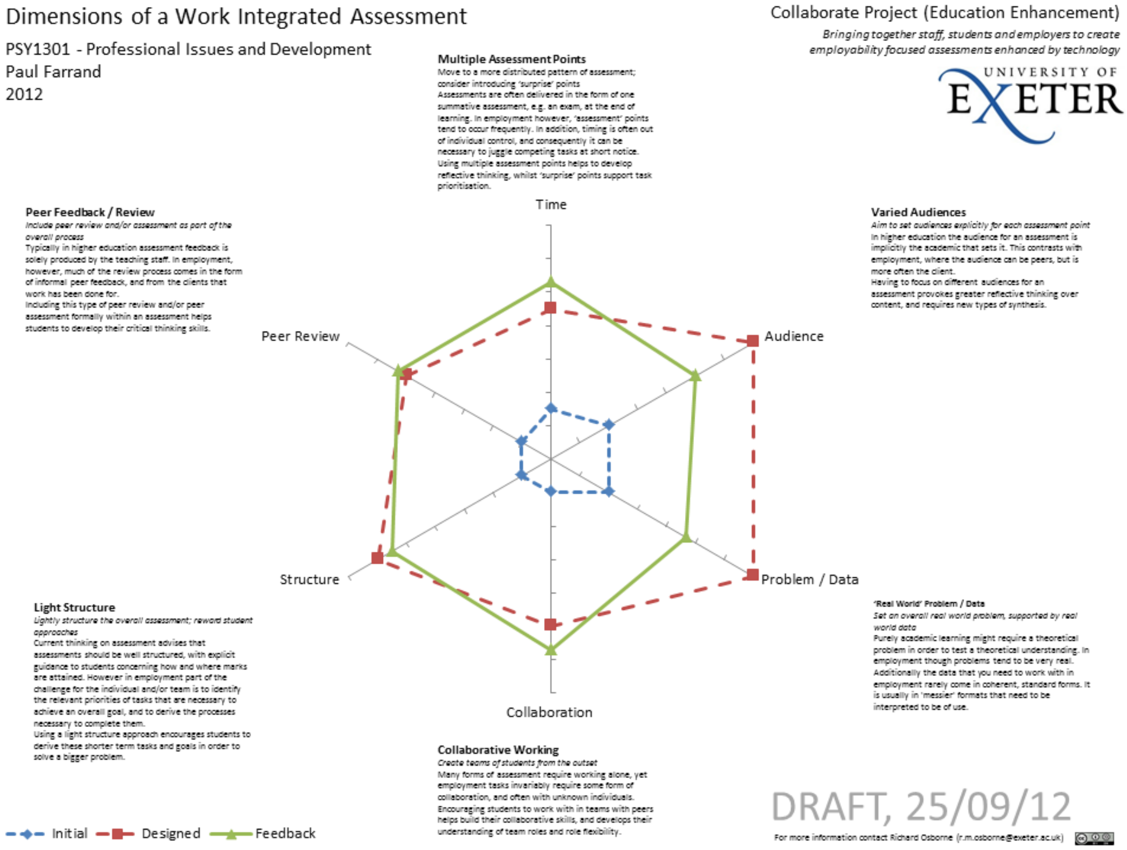


Figure 7.50: Drag and Drop skills evaluation (2012/13)

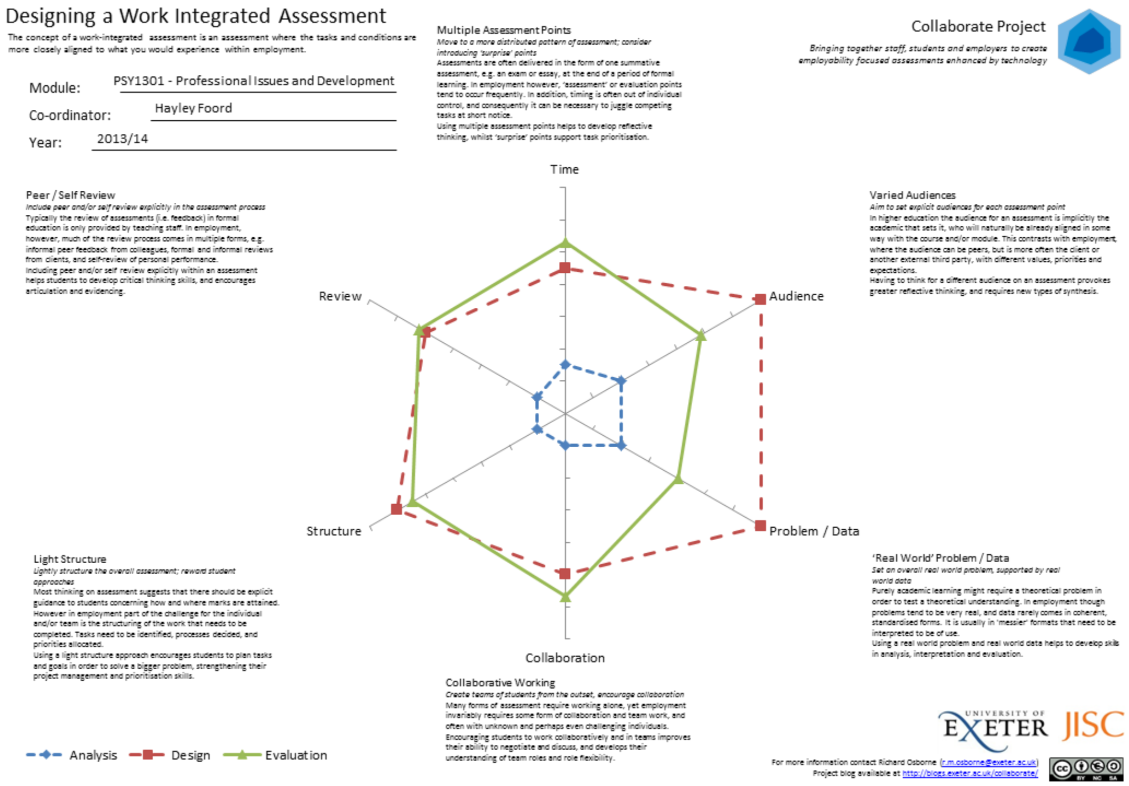


Figure 7.51: Drag and Drop skills evaluation (2013/14)

Bearing in mind that these iterations took place in two separate years, with a different set of academics and different students, the drag and drop skills evaluations are strikingly similar. An analysis overlaying the two evaluation lines from these charts shows a very minor difference in Audience between them, and a difference of approximately 1 tick mark on Problem / Data, but all the other data points match each other almost exactly.

This raises the possibility that the tool itself is not sensitive enough to pick-up differences between groups, but repeated testing in other contexts would appear to refute this. The polygon produced for module MLS3049 for example, as shown in Figure 7.41, is quite different to those produced for module PSY1301. Two other examples of this testing are shown, one with the University's own Education Quality and Enhancement division (Figure 7.52, n=9) and one with a cohort of Bioscientists (Figure 7.53, n=14), are also shown below for comparison. Both of these show quite different polygons, either in terms of size (i.e. how much they spread down each dimension), or in terms of shape (i.e. how different the measurement is across individual dimensions).

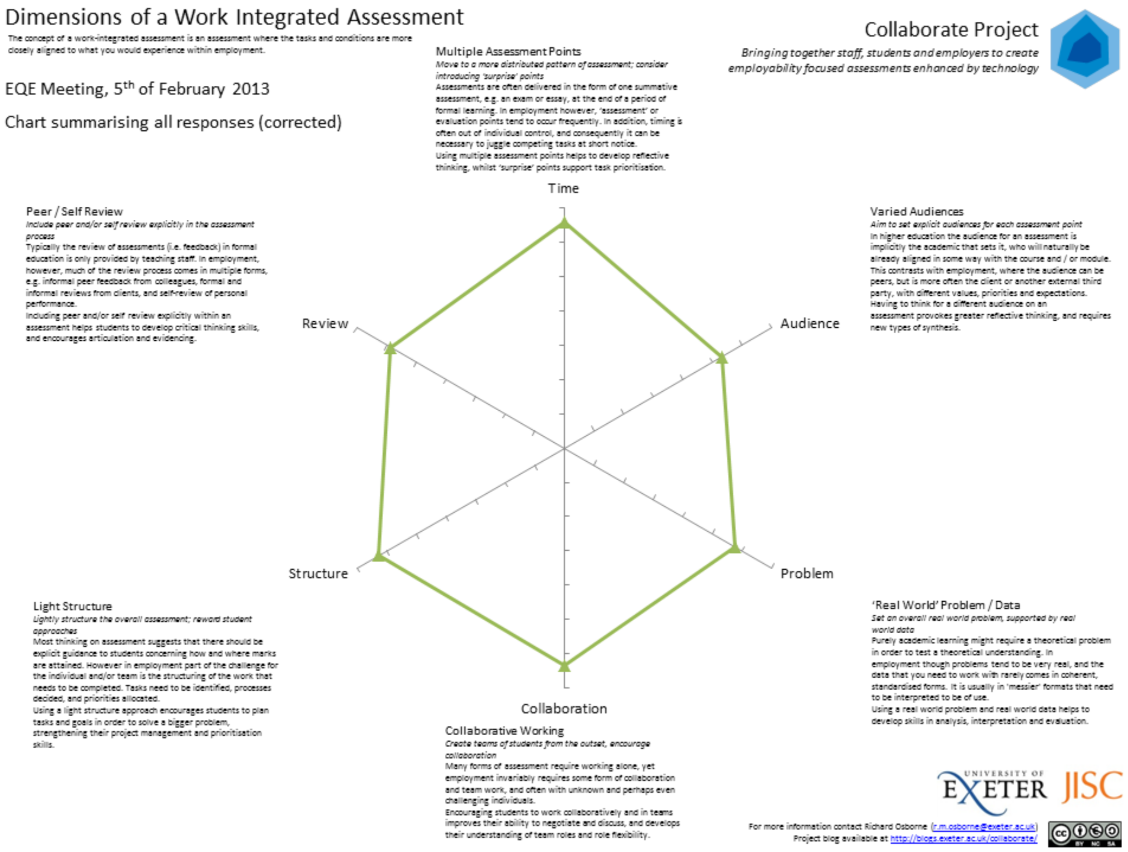


Figure 7.52: Drag and Drop skills evaluation (Education Quality and Enhancement)

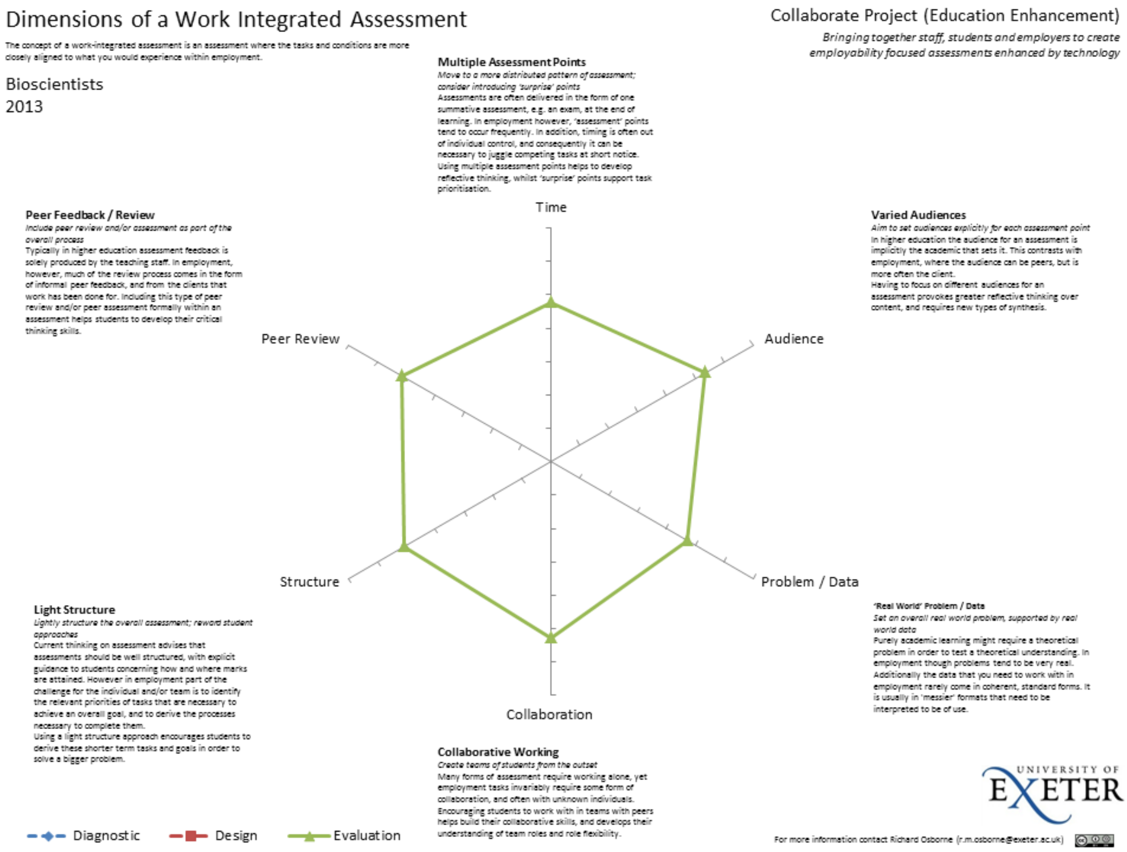


Figure 7.53: Drag and Drop skills evaluation (Bioscientists)

Results from this evaluation suggests that the pedagogic design is stable, i.e. that the learning outcomes as designed through the dimensions model are being achieved. In both cases the evaluation shows that the Structure and Collaboration dimensions were the most highly rated, and these were the dimensions that were being targeted specifically, using digital technologies as support.

Formal interviews / informal feedback

Interviews with academic staff and students appeared to corroborate analysis of the evaluation data, in terms of the development of team working skills and professional knowledge.

> "[students developed] a good idea of the essential skills of team working, and working towards deadlines and targets."
>
> PSY1301 Module Convenor (2012/13)

> "They've also learned a lot about the main aims of the assessment ... they've met the academic aims of the assessment."
>
> PSY1301 Module Convenor (2012/13)

The quality of the work produced was deemed to be particularly high according to the externals brought into the process.

> "I have worked a lot with various mental health teams, people who have had years of experience, and I can honestly say I have never seen such wonderful leaflets as you have produced today"
>
> PSY1301 Employer Marker

> "I have learned a lot from our service point of view in terms of how to present information to students, and I shall take these back and I know we shall start to

look and how we can implement what they have been telling us this morning."

PSY1301 Employer Marker

Regarding the specific technologies chosen, academic leads reflected that students had a flexible approach to technology use, for example two groups in the 2012/13 iteration decided to use Facebook to organise work rather than the suggested tools.

> "Two groups did use it [Trello]. Two groups used Facebook, which was absolutely fine, they all used something."
>
> PSY1301 Module Convenor (2012/13)

> "The students used different technologies, one technology that they seemed to use, two groups used spontaneously, was Facebook ... they set-up a Facebook page to support the project itself, and they used that quite extensively. They adapted technologies that they were familiar with to serve this purpose."
>
> PSY1301 Module Convenor (2012/13)

This type of innovative use of technology would be expected according to the concept of interpretive flexibility (Pinch and Bijker, 1984), but suggests that the Tech Trumps do need refining further. Crowdsourcing, i.e., using student input to moderate star values over an extended period of time, might be a possible long-term solution. Facebook was not considered as providing enough Structure to warrant 5 stars for this dimension, though does score 5 stars for Collaboration.

Facebook was explicitly suggested in the 2013/14 iteration, due to feedback received in the 2012/13 iteration and in other iterations with other modules, and did appear to be widely used:

> "They did use Facebook, I think that's very, that's something they're used to

> using so they kind of changed their Facebook dynamics and set-up."
>
> PSY1301 Module Convenor (2013/14)

Interviews and feedback from students provided multiple suggestions as to why Facebook was so popular, for example "Everyone's on it every day" and "It was a social project". This could be said to highlight the relational nature of affordances and the importance of intention driving awareness. The learning value of something that is commonplace for students can be highlighted by alignment with a specific learning challenge, though sometimes this can be so implicit as to remain almost hidden. On several occasions it took multiple prompting with students to uncover how they were using technology, and this might be an intrinsic problem with the use of the word technology itself. Often initial replies to questions about technology might concern use of Microsoft Office applications, or other software more traditionally associated with education. The use of other digital places, such as Facebook, seemed so implicit in their activities as to be forgotten or not worthy of mention, even though it did seem to permeate their learning.

Facebook's main affordance seemed to be in providing an extension to the group's ability to communicate:

> "For communication with everyone, and just, sending files to each other so we're all on track with what we were doing."
>
> PSY1301 student (2013/14)

But also in the ability coordinate between real world and digital world activities:

> "We could easily update our progress as we went along, we'd send our files to the .. team leader and then they'd have everything for the group meeting ready ... rather than everyone just bringing loads of paper ... having everything on a

> memory stick and email was a lot beneficial [sic].”
>
> PSY1301 student (2013/14)

Another technology that some groups brought to bear on the challenge was WhatsApp, which provides very similar functionality to what other students were getting from Facebook:

> “Especially WhatsApp and Facebook group message to easily arrange group meetings was particularly important.”
>
> PSY1301 student (2013/14)

As a result WhatsApp is now a Tech Trump. Again it seemed that whatever ecosystem was currently most popular amongst the student group would be the one that was adopted.

The Trello software was only adopted by a small number of students, but it was deemed to be “absolutely excellent” in supporting their team working and time management, and has now been adopted by some students for all their studies.

> “[Trello] seemed, from what they report in their presentation, absolutely excellent, and I know one or two of them are now using it basically to schedule their own study.”
>
> PSY1301 Module Convenor (2012/13)

Students also reflected that although the technology did not suit everyone, for some it became essential:

> “We were quite varied in the group, some people really didn't like it, because they found it, it was too complicated. I think it was really good, because you

> could get, you know you got the emails when the deadline was coming up."
>
> PSY1301 student (2012/13)

This underlies the relational nature of affordances, that individuals will find the match with technologies that suits them, and that one specific technology does not suit all. This validates to some extent the overall design framework, in that it intentionally suggests multiple technologies that have the capacity to support a single pedagogic design.

As in experiences in other iterations, once the affordances of a technology have been discovered they appear to be easily transferred to other contexts. This student commented on how they now use the Trello software across all their University work:

> "So sad, I used it to set up one, for like, all my Uni work now, and my cleaning at home."
>
> PSY1301 student (2012/13)

Student also reflected on the benefits of gaining experience with these types of technologies that can then be applied in the workplace, for example:

> "It's good because you get, like, deadlines and stuff and you can keep on top of it and everything's there and I think it's quite an easy format because it's just do, doing, done, so I think it was good, and it's definitely useful to get practice using something like that because if you ever have to do a team project after University its good to know things like that are there."
>
> PSY1301 student (2012/13)

Similarly in the 2013/14 iteration, the Trello software was quite popular according to the academic convenor:

> “They all seemed quite enthusiastic about it [Trello] ... I’m pretty sure 5 or 6 out of the seven groups used it, if not all 7.”
>
> PSY1301 Module Convenor (2013/14)

The software appeared to provide a specific affordance in terms of extending the space for dialogue:

> “They spoke about … how good they found it at supporting their learning and they could keep in contact with each other when they couldn’t actually meet face-to-face.”
>
> PSY1301 Module Convenor (2013/14)

Though once again what stood out was that the software only appealed to certain individuals, students who were already using Facebook, for example, chose to stick with that digital place.

> “Although we were briefed about Trello ... I felt it wasn’t necessary, it was nice to see it there, but we went through Facebook.”
>
> PSY1301 student (2013/14)

The Team-Match software was useful in highlighting to the students their own strengths and weaknesses in both iterations, though it was not used to form teams. Little reflection on the software was observed through interviews and informal feedback.

Summary

This iteration focused on supporting the dimensions of collaboration and structure. Analyses of data gathered from the evaluation sessions with students all showed that the students had developed their collaboration skills. Analyses of the postcards data and the skills drag and drop exercise suggested that the students had developed time management skills, their ability to work autonomously and their capacity for self-reflection. Whilst it is not possible to claim a causal relationship between the technologies used and these results, there is a strong correlation between the designed objectives and the evaluated outcomes in terms of developing skills and competencies. It is proposed that this is at least in part due to the alignment of the most appropriate technologies with the pedagogic design. To use the language of post-positivism, the data provides a good warrant for the successful alignment of pedagogy and technology.

Findings

The completed iterations as presented do suggest that the dimensions model was effective in capturing pedagogical intention in these four contexts, and that the affordances approach can support the alignment of technologies with a specific pedagogic intention. The data as presented also appeared to satisfy the success criteria for design-based research, as outlined earlier in Chapter 5:

- The overall design principles that form the dimensions model are now stable, and do appear to provide a useful frame in which to capture pedagogic intention.
- The practical outputs themselves, in terms of the dimensions model and its associated Tech Trumps, are also stable, and are recognised by peers as having practical value outside of the research.
- Finally, participants reflected positively on their experiences within the research.

Whilst there remains more that could be done to improve and further evaluate the Tech Trumps in practice, these four examples of use do show varied but successful alignment between a designed pedagogic context and a number of digital technologies. A short summary of what has been learned is presented, mapped against the three research questions as outlined in Chapter 5.

RQ1: What role does intention/need play in the detection/use of affordances?

According to Gibbs and Simpson (2004) what students attend to, how much work they do and how they go about their studying are completely dominated by how they perceive the demands of assessment. Assessment frames their thinking; it focuses intention. The objective of the dimensions model was to capture that intention in a defined form that could then be used to align digital technologies, exposing potentially relevant affordances. Chapter 3 has set out how affordances are only attended to if they relate to what someone intends, hence this capturing of intention is an important part of the overall affordances jigsaw. In the iterations outlined in this chapter this does seem to have been effective. In the three iterations discussed different pedagogic challenges were set, many different technologies were suggested, and in all three contexts the data has shown how some suggested technologies played an important role in supporting staff teaching and/or students learning.

The relationship of the affordances concept to these findings centres on the notion of intention driving attention. The notion that affordances are relational is widely appreciated, but often this relational nature appears to relate to the physical or cognitive attributes of individuals in a general sense. Whether they have the necessary grip or height to reach or grab something, or perhaps whether they have the spatial or linguistic skills to be able to decipher or analyse something. What this potentially misses is the context that the individual finds themselves within, and the fact that objects and situations have multiple affordances at any one time, where the affordances that are attended to are based on individual intention driven by their specific context. Affordances not just as relational in the individual in a general sense, but as relational to the specific time and space that the individual finds themselves within the wider environment.

Arguably the focus on physical or cognitive attributes is partly due to the generally accepted definition of affordances as ‘action possibilities’, which naturally leads to an understanding of affordances as what someone can do with something. Intention, in contrast, suggests wanting to get something back from a person or situation, what something might ‘provide or furnish’ to use Gibson’s original definition. A new understanding of affordances is proposed that might unwrap more potential in the concept, the notion of affordances as ‘transaction possibilities’. This shifts the focus away from what people can do *with* something, back to Gibson's original notion of what something - or for that matter someplace - might do *for* someone, i.e. what it might provide or furnish. This concept of affordances as transaction possibilities is discussed further in the next Chapter.

RQ2: What invariants within digital technologies make affordances possible?

Work at School A showed how the timeline which formed the core of the Adobe Visual Communicator software gave rise to multiple affordances, one single invariant could be used in multiple ways, and hence support multiple affordances. The Tech Trumps built upon this basic understanding, and attempted to highlight how a single technology might have multiple affordances, depending on context. The same underlying invariants with a single technology could be used in different ways according to need. Team-Match’s personality profiles helped to scaffold personal development, but at the same time helped teams to identify and plan roles to improve collaboration. Google Drive acted as a central repository for students, helping them to cumulatively build a portfolio of work, and provided a digital space for reflection and synthesis. Its affordance in this case, what it provided or furnished, was a space for reflection. But that same collection of digital objects also provided a shared digital space between student and academic, broadening the potential audience and leading to a dialogue about the content. Facebook’s timeline provided both a method for understanding and delegating tasks, but also provided another extension to dialogue, enabling conversations to continue beyond physical spaces. Underlying invariants gave rise to multiple affordances.

The questioning technique that was devised in order to rate the technologies according to pedagogical intention, as laid out in the dimensions model, seems to be the key element that makes explicit how invariants within a specific technology might give rise to affordances. It challenges the learning designer to think creatively about what these invariants might provide. For example, threaded or nested commenting might lead to greater peer review and collaboration; the ability to save and browse structured content over time could help to develop self-reflection; being able to visualise others might help to develop a sense of community and team identify; being able to share with third parties might help to bring in different voices and extend the dialogic space.

By using the language of Gibson, in terms of what something might provide or furnish, the mind is forced to explore invariants in order to extract potential affordances. The questioning technique forms the missing component of the design framework, linking intention/need with specific technologies, but doing so in a flexible way which allows individuals to map their own take on what it is important to them with suggestions from the Tech Trumps.

RQ3: What do learners receive from a digital technology, when used in an educational context?

The meta analysis has illustrated how both academics and students have received many different types of things from their use of learning technologies, Trello providing structure for planning for example, Facebook the flow of dialogue to support teamwork, GradeMark a framework for critiquing student work, and so on. What seems common across these and other experiences is that they have received *something* back, i.e. that they have not simply taken *actions*, instead they have taken part in a series of *transactions* with digital technologies over an extended period of time. The affordances of the digital technologies in these contexts cannot be explained simply as action possibilities.

To use an ecological model, one potential way to pull together experiences across the iterations is to suggest that the digital technologies have provided an extension of the learning habitat. The space within which the students and academics have been working, traditionally the real space of the classroom, lecture theatre, office or study, has been extended by the digital technologies on offer. Facebook and WhatsApp have extended the opportunities for dialogue, Trello has extended the real world notepad, lists of things to do, Scoop.it has extended the physical dossier, creating a potentially unlimited portfolio. This extension might be visualised as a series of wider digital places superimposed onto real places, as shown in Figure 7.54, but with the unique capacity to cross over between real places. As Chapter 4 has argued, digital places are not as constrained as real places, and just as it is possible to move between digital places instantly without moving through any intermediaries, so the digital place can ‘join up’ real places in a way which would be impossible without the technology

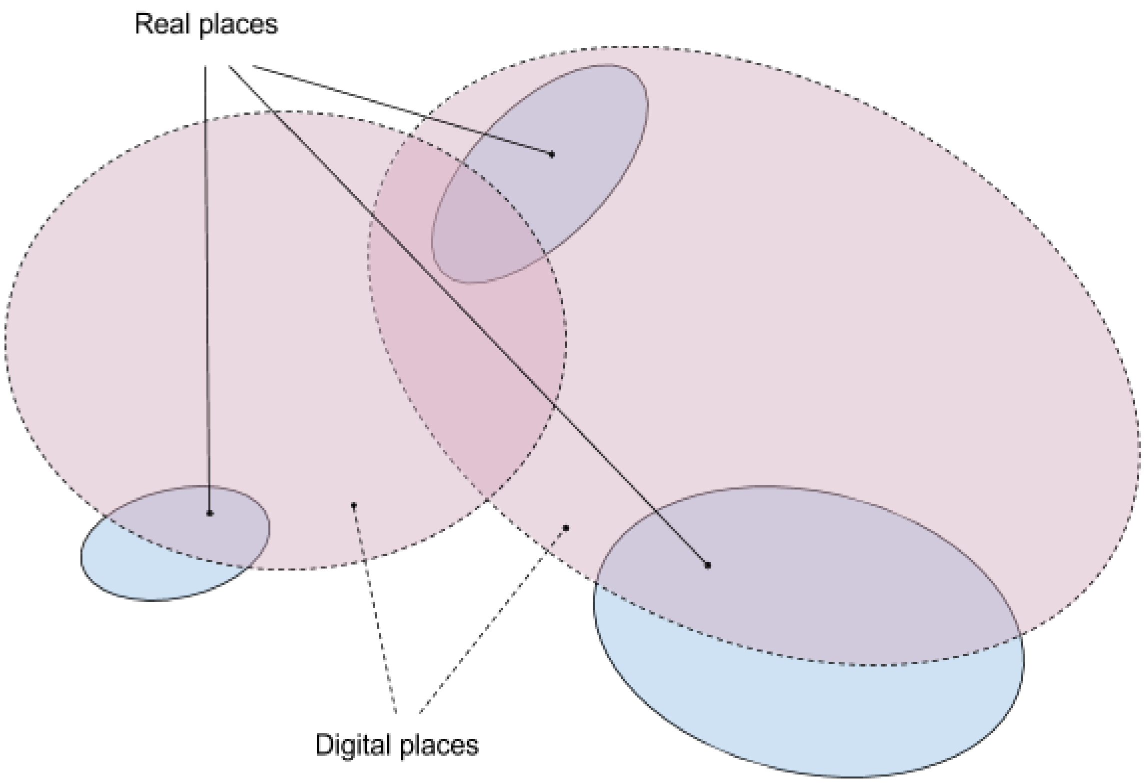


Figure 7.54: Real places vs digital places

The effect of the digital technologies suggested by the design framework on the students learning experience might perhaps be summarised as extending the students ability to transact, both with each other, and with their own digital representations.

Summary

This chapter has documented the research that was undertaken at the University of Exeter. The narrative has described the development of the initial design framework from School A into a stable design framework at Exeter, using it to capture pedagogical intention and align digital technologies in multiple disciplines, in order to analyse and understand whether affordances can be used as a design tool to align pedagogy and technology. A meta-analysis of data gathered through iterations using this design framework in practice with participants suggests that the questioning technique that was developed using Gibson's original conception of affordances as a guide for alignment, in order to identify the 'space of possibilities' of affordance that links intention and invariant, has helped academics and students to understand the value of specific digital technologies in their contexts.

The next chapter discusses the findings from both this chapter and the research at School A, in relation to existing research literature and the design-based research approach that was taken. Using Edelson's (2002) trio of theoretical contributions that design-based research might provide: those of domain theory; design framework; and design methodology, as lenses through which to view the current research, contributions are discussed in each case. Reflections and lessons learned on the design-based research process are also offered.

Chapter 8: Discussion and Interpretation

> *"Discovery consists of seeing what everybody has seen and thinking what nobody has thought."*
>
> Albert Szent-Gyorgyi

Introduction

This chapter discusses the potential significance of the findings presented in Chapter 6 and 7, how they relate to existing research literature as explored in Chapters 2, 3 and 4, and the big emergent issues they suggest. Combining findings from research questions as discussed in Chapters 6 and 7, it uses Edelson's (2002) trio of theoretical contributions that design-based research might provide: domain theory, design framework, and design methodology; as lenses to frame the discussion and interpretation of these findings. The design narratives are re-explored in relation to earlier discussion of affordance and the digital environment, and potential contributions from the research are proposed.

Framing discussion

Design-based research is an evolving methodology, and as such different practitioners have adopted different ways to both carry out the research and to write about it. Whilst there may be differences between approaches, a common characteristic to all is the duality of both design and research. It is both a process of design in itself, but also a process of research, and these two intertwine. 'Straight' design focuses on an individual product, and bringing that product to the marketplace, where lessons learned and knowledge gained tends to be wrapped around that specific product and those involved in the design process. Design-based research, in contrast, expands beyond that specific product and process, and critically it offers not only a designed product and the process through which it was designed, but also a contribution to the theory behind that process. As Obrenović (2011) argues, for design to be classed as research, it must produce generalizable knowledge. Edelson (2002) has proposed three different forms that this might knowledge might take:

- Domain theory: A domain theory attempts to explain the underlying processes through which specific behaviours are occurring within a specific domain area
- Design framework: A design framework is a prescribed way of achieving a specific goal by using a defined process
- Design methodology: A design methodology is a more generalised view of a design framework, which focuses on how the individual components of a design framework fit together to produce outputs

Chapters 6 and 7 explored findings from research at School A and Exeter using the three research questions as laid out in Chapter 5. These research questions were in turn derived from the affordances trinity as outlined in Chapter 3, in order to use the three components of affordances as a “tool to structure inquiry”. However, these three can also be seen as one whole, in which the transactional ‘space of possibilities’ of affordance is like an inclusive boundary defining the internal (intentions) and the external (invariants) as these emerge out of interactions and mutually condition each other. Affordance is a complex intertwined concept, and in order to fully discuss what the findings might mean, it is therefore necessary to recombine the findings from the research questions as outlined in Chapters 6 and 7, and interpret the overall contribution the research might provide. In order to do this, Edelson’s three forms of generalisation are used as lenses through which to view the findings from the research questions, to frame both discussion and interpretation of the current research, and offer potential contributions:

- Firstly, contributions under the heading domain theory are proposed: a new way of thinking about affordances that returns to Gibson's original concept, affordance as 'transaction possibilities'
- Secondly, the specific design framework that was designed is analysed, in relation to other approaches to educational technology, the theory of affordances and conceptions of the digital environment
- Thirdly, a potential design methodology is explored, by extrapolating from the design framework how its individual components fit together, and the processes needed to create it, in relation to the domain theory

To conclude, some thoughts on the design-based research are presented on the importance of interim reporting and the benefits of including success criteria.

Domain theory: Affordance as 'transaction possibilities'

> "A domain theory is the generalization of some portion of a problem analysis. Thus, a domain theory might be about learners and how they learn, teachers and how they teach, or learning environments and how they influence teaching and learning ... even though a domain theory in design research is developed through a design process, it is a theory about the world, not a theory about design per se."
>
> Edelson (2002, p. 113)

The review of the existing literature and interpretation of the theory of affordances in Chapter 3 has explored both the widespread disagreement concerning the term and repeated misappropriation of the original concept with other derivatives, such as the work by Norman (1988) and Gaver (1991). Although Norman has since recognised that his version of affordance is different to Gibson's original concept, and has proposed a change in his own work to use the word "perceived affordance" to clarify this difference (Norman, 1999), his contribution appears to have catalysed a widely held belief that affordances are synonymous with 'action possibilities'.

It is perhaps an inevitable consequence for all theory as it ages that it tends to diverge over time due to re-examination and re-interpretation, and arguably this is a necessary and valued part of the evolution of thought. In this case however, an examination of the primary sources for the theory of affordances (Gibson 1977; 1979; 1982) has revealed no trace of 'action possibilities' being related to the concept of affordance. Chapter 3 has argued that this link with 'action possibilities' has diluted the original concepts power, and led to its current questionable value within educational contexts (Oliver, 2005). The notion of affordances as synonymous with action possibilities appears to have become prevalent through the work of other interpretations, most notably the work of Turvey and Norman. It has been argued that the use of this definition limits the power of the concept, reducing it to simplistic stimulus and response type actions.

The present research has attempted to return to Gibson's original conception of affordance, with its overall goal of understanding how individuals derive meaning from the world around them. It has argued for a more 'functional' approach to affordances, one that re-establishes how affordance is related to time, and what an individual *receives* from interaction with the world. In particular it has focused on the trinity of how intention shapes what affordances individuals attend to; how invariance shapes what about the world has the potential to be an affordance; and how the actual affordances that are experienced link these two in practice. Three research questions were proposed to focus the research on these three key aspects of affordance, specifically:

- What role does intention/need play in the detection/use of affordances?

- What invariants within digital technologies make affordances possible?
- What do learners receive from a digital technology, when used in an educational context?

Analysis of data in the design narratives of Chapter 6 and Chapter 7 has already provided some thinking regarding these three questions, and therefore on understandings of affordance. In particular it has highlighted:

- How pedagogical intention shifted what is attended to at different stages in learning. Both research at School A at and Exeter has shown how the same invariant can lead to different affordances in different learners according to their needs, for example the timeline in Adobe Visual Communicator acting as either error checker or prompt for thinking, or Team-Match providing both personal reflection or team strengthening collaboration.
- How invariants within a digital place can be isolated and aligned with a pedagogical context using a questioning technique, in order to highlight specific affordances relative to that context. For example, how the way in which Trello is designed can support the development of project management skills, or how the intrinsic nature of Facebooks social connectedness helps support peer and collaborative approaches to learning
- How learners receive back from digital technologies a stream of their own thinking, and potentially the thinking of others, in an ongoing transaction with the digital place that forms those technologies. This was most clear during work at School A, where learners were embedded in a single digital place, but also at Exeter with digital technologies such as Scoop.it and Google Drive

Rather than focus once again on the three research questions as listed, further discussion attempts to interpret what the findings from the research questions in Chapters 6 and 7 imply for the wider theory of affordances, and conceptions of the digital environment.

Emergence of active vs passive affordances

The work at School A as described in Chapter 6 has highlighted how intention/need seemed to drive the detection and use of affordances, but it also seemed to reveal another side to affordances, active versus passive use. Sometimes the students used affordances in very active ways, e.g. manipulating the timeline to produce specific results as documented in the ‘Control of time’ section of Chapter 6 (p. 215), i.e. the slowing down or speeding up of time, and sometimes the affordances seemed to be more passive, e.g. the use of digital place to reflect on digital artefacts that had been created. Similarly for students using Facebook for collaboration at Exeter, whilst some reported the ability to share was important, others highlighted the ability to receive feedback (p. 340), what might again be termed a passive affordance. This notion of passive affordance seems novel, and raises the question: has the focus on affordances as action possibilities unintentionally shielded a side to affordances that has not been well explored?

The descriptions of affordances that are linked to definitions based on ‘action possibilities’ tend to focus on active use of things in the world, pushing knobs, turning wheels, clicking switches, etc. Gibson’s original definitions, in contrast, whilst including very active use of things in the world, also included reference to affordances which might be better described under the banner of ‘passive affordances’: Firm surfaces that can be walked upon, doorways that can be passed through, hiding places, shelves for storing things, etc. (Gibson 1979; Gibson, 1982). The examples do not support action on them, they cannot be turned or pushed, and they cannot be picked up and used to cut or write. The nature of the objects or places provides an affordance through their form. Similarly in the current research, digital technologies might in some cases have provided learners with the ability to take certain actions, writing a blog post perhaps or sharing a portfolio with their lecturer, but a large part of their value seems to have come from passive affordances. The reflection supported by an ongoing blogging process in Word, the emails from project management software Trello reminding about deadlines, the pre-scripted marking comments from lecturers supported by GradeMark, all of these were done *to* the individuals, not *by* the individuals.

The action possibilities approach to affordances has been mostly attributed to the impact of Norman (1988), a man best known for his work on design. The designers' chief aim in life is to ensure that the products that they create can be used, they are therefore perhaps more focused on active affordance. They are not necessarily as interested in how their products change people, on what has been termed passive affordance. However the educator is entirely concerned with how to change people. Learning is, after all, a process of change. From Skinner's experiments with stimulus and response, through Piaget's theories of adaptation, on to Wenger's notions of duality, change is implicit in theories of learning. The educator is interested in how actions in the world impact individuals, not simply action or interaction, but what learners get back from these. The designer may be primarily interested in *action* and *interaction*, how something might be used, but the educator is surely more interested in *transaction*, what someone gets back from use. This suggests a new term that might be used to describe affordances, that includes affordance both in an active and in a passive sense, the notion of affordances not as action possibilities, but as transaction possibilities.

Transaction possibilities

The term 'action possibilities' has been popular and successful, therefore it is logical to suggest that it does in some way succinctly summarise an aspect of affordance that is useful and valuable. But at the same time it has been argued that the term falls short of a complete explanation of affordance. It is proposed that the new term 'transaction possibilities' might help to clarify the meaning of affordance, especially within education, to replace the unhelpful and arguably incorrect 'action possibilities' that has become so synonymous with the concept.

The notion of a *transaction* brings back to the affordance concept what someone *receives* from an interaction in the world, as opposed to simply what they *do*. It is a more ‘purposeful’ term (Dillon, Prosser and Howe, 2004) and therefore links back to the intentional aspect of affordances. It also restores to the concept that fundamental element of affordance that was so crucial to Gibson’s original definition, what something might “provide or furnish”, as at the heart of every *trans*action something is returned to the originator. An action may summarise what someone does *to* the world, and an interaction *how* someone acts in the world and in turn is acted upon, whereas a transaction signifies what someone receives back from the world.

These three words - action, interaction and transaction - were also discussed in depth by one of the foremost thinkers in education, John Dewey, in his last work “Knowing and the Known”. Dewey had always argued that education is experience, but perhaps more tellingly that:

> “An experience is always what it is because of a transaction taking place between an individual and what, at the time, constitutes his environment.”
>
> Dewey (1938, p. 43).

Dewey had already been connecting action to consequence in his earlier thinking about education, and his emerging ideas on the importance of transaction can be seen in his earlier work “Democracy and Education”, when writing about the emergence of meaning:

> “To have an ‘idea’ of a thing is thus not just to get certain sensations from it. It is to be able to respond to the thing in view of its place in an inclusive scheme of action; it is to foresee the drift and probable consequence of the action of the

thing upon us and of our action upon it."

Dewey (1916, p.34-35)

Similar to the arguments put forward in Chapter 3 that affordance might be understood as the meaningful consequences of action, so Dewey understood the importance of consequence, but more than that he was suggesting that it is an understanding of the transaction that is crucial; not simply action on the world, but also how the world acts back on you. Not so much the action possibilities, but the transaction possibilities.

Chapter 6 noted how during the research at School A it was the speed of interaction which was partly credited with having a positive impact on the student learning. Reflecting back on that notion with the current thinking in mind, it is proposed that it was not the speed of *interaction* but the speed of *transaction* which was important. Discussion has focused on how the students engaged in cycles of construction and destruction (p. 210), they did not simply interact with the digital place, they used it to frame their thinking, reflect on it, and change it. The digital place provided back to them a view of their own thinking, but also provided the space in which to change it. This matches back to Chapter 4's notion of interface and place being separate, and previous notes in Chapter 6 on the importance of reaching a digital place through interface. Interaction happens at the interface level, but transaction happens at the place level. Interaction is critical in order to be able to make use of the place, to perceive, move and change the place, but transaction is at a 'higher' level than this.

Research at Exeter has also repeatedly suggested that for students the key affordances within the technologies were to do with the type of *transaction* that was supported, not the type of action. Students who used Facebook, for example, made references to the way in which it supported extended activities over time (p. 339), it became a place that supported numerous different transactions between individuals within teams. It did provide the ability to post ideas and thoughts, what might be referred to from an affordances perspective as the more classic action possibilities, but more critically it also provided reflections back on those ideas from others, it provided transaction possibilities.

Students using the Scoop.it curation software likewise engaged with the digital place that they were creating over an extended period of time, it became a place that provided transactions (p. 349). Students not only used it in an active way, adding to the repository over time, but in a passive way. They noted that it provided the ability to review previously added content, not just add new content, suggesting again that the digital place was providing transactions separately from their active engagement.

In the Psychology module, students who chose to use Trello specifically remarked on its abilities to remind them of deadlines and things they should be working on (p. 371), suggesting that on top of their active use in terms of filling in what needed to be done, it also provided passive use in terms of being reminded when those things were due. Actions were not only taken by the students, but actions were also taken by the software itself, to set-up a series of ongoing transactions between individual and digital place.

Place supporting transaction

Kolb (1984) recognises that an understanding of learning as transaction between individuals and the environment seems at first hand too simple and trivial, but that at the same time this way of understanding learning is often only paid lip service.

> “Learning involves transaction between the person and the environment. So stated, this proposition must seem obvious, yet strangely enough, its implications seem to have been widely ignored in research on learning and practice in education.”
>
> Kolb (1984, p.34)

The role of the wider environment in learning, and its impact on it, “seems to be actively rejected by educational systems at all levels” (Kolb, 1984, p. 34). Similarly, it could be argued that the impact of the digital environment on learning has been marginalised by treating technology as tools that exist on the edge of learning, that are brought in and applied to ‘real’ learning’, rather than as places in their own right. The work at School A in particular, where the digital environment played a central role by providing a digital place for learning to take place within, highlighted how the lack of that environment negatively impacted learning (Table 6.6, p. 200). When the technology broke down, and the digital environment was unavailable, no learning took place.

The experiences of students within this research would suggest that digital technologies provided an experience in this sense, technology as place. Technology provided a series of ongoing places where negotiations, curation, editing, planning, etc. took place over an extended period of time, e.g. keeping in touch (p. 372), building ongoing resources (p. 350), reflecting on progress (p. 338). To a large extent the digital technologies themselves constituted the environment that the students experienced, or at least a large part of it. To use ecological terminology, the digital technologies provided the habitat for the students; they found their digital niche and kept returning to it. They had discovered the affordances, the transaction possibilities, which the digital technologies could provide for them.

The notion of digital technologies as place rather than tool, as explored in Chapter 4, is arguably key to the idea of affordance as transaction possibilities. Tools tend to be positivist in nature, they have specific purposes that they were designed to achieve. A screwdriver is designed to tighten and loosen screws, a nutcracker to break open hard shelled nuts, a torch to illuminate dark places, and so on. A tool might be referred to as something to do something *with*. A place might be referred to as something to do something *in*. The tool to a large extent determines what potential actions can be done with it by its form. The place, in contrast, is more flexible, and provides a range of potential transactions or affordances depending on need. Places are less instrumental in defining how they might be used, what might be seen as a post-positivist observation. A large covered place such as a community hall might host discos, markets, council meetings, etc. A bus stop might shelter waiting passengers, provide seclusion for teenagers or refuge for someone without a home. A busy shopping centre might provide pleasure through the easy access of goods, an opportunity to find and interact with peers, or a place to watch and observe human behaviour. Similarly, Facebook becomes a place for discussing and reviewing educational issues as they emerge through the learning process, providing for reflection and different perspectives on thinking. Scoop.it becomes a personal library of information relevant to a specific learning challenge, providing a sense of focus to support analysis, evaluation and synthesis. Trello becomes a place to structure and plan activities, providing a scaffold for ongoing engagement with a broader learning challenge.

Defining affordances as action possibilities has certainly been productive in many ways, providing a simple way of thinking about the concept that has been particularly successful in disciplines such as HCI. Arguably however this simplicity may in part explain why the term is so divisive in educational settings. The arguments put forward here would suggest that extending this definition of affordances from action possibilities to transaction possibilities broadens and deepens the power of the concept, brings in more in line with Gibson’s original conception, and opens up the possibility of digital technologies as digital places. Places provide or furnish something to their occupants whether or not they take any actions, the very state of being in a place can provide an affordance. The notion of an affordance as a transaction possibility provides a more complete definition that can explain what digital habitats might provide irrespective of action.

Design framework: Dimensions model and tech trumps

> "A design framework is a generalized design solution. Although domain theories are descriptive, design frameworks are prescriptive. They describe the characteristics that a designed artefact must have to achieve a particular set of goals in a particular context. A design framework is a collection of coherent design guidelines for a particular class of design challenge."
>
> Edelson (2002, p. 114)

The concept of the design framework is that design principles are framed together to create practical tools for a specific design scenario, such as that carried out to align the principles of authentic assessment with digital technologies that might support that assessment. The current research has produced a specific design framework to align authentic assessment with digital technologies, using affordance as 'transaction possibilities', which is comprised of two elements:

- A dimensions model using six design principles that together define the necessary conditions to create an authentic assessment, and hence define the intention of learners
- A series of Tech Trumps that translate the invariant properties of a wide range of digital technologies into potential affordances aligned to the dimensions model

This design framework is intended to capture the key aspects of the affordances trinity, namely the two 'ends' of affordance as outlined in Chapter 3, the ends of intention and invariant

Dimensions model to capture pedagogical intention

The importance of context in learning has wide appreciation, the theories of situated learning (Greeno, 1998; Brown, Collins, and Duguid, 1989), for example, suggest the context of the learning is fundamental to the knowledge that is gained. Yet the context when considering the value of digital technologies to learning is often ignored. Digital technologies can often be seen as lacking context entirely, as only tools to be added to an existing context. Intention is also a key part of learning. A designed learning scenario should be constructively aligned, with specific learning intentions made explicit both for those facilitating learning and for learners themselves (Biggs, 1996).

Context and intention is also crucial to the affordance concept. Any one context has multiple affordances, but the affordance that is attended to is based on need or intention - what affordances are attended to at any one point in time are directly related to an individual's intentions at that point in time (Gibson, 1982). A learner focusing on collaborative learning, for example, would be inclined to attend to affordances which supported collaborative activities. A learner focusing on analysis of data would be more inclined to attend to affordances which support analytical activities, and so forth. This importance on context and intention seems to have been overlooked in Oliver's (2005) critique of the affordances concept. In their analysis of the nature of affordances they dismiss the possibility that affordances are historical because "all that could be said then is that a thing *afforded* something to someone in a specific circumstance, not that it *affords* it in general." (Oliver, 2005, p. 403 [their emphasis]). From the point of view of the current research, this is entirely the point. Every affordance has a context or specific circumstance within which it "provides or furnishes" something specific to the individual. To describe affordances outside of context may be theoretically possible, and but at the same time it is suggested is analytically empty.

Evidence from the current research would seem to support this statement. For example, when Psychology students were challenged to develop their own project management skills, by removing structure from their learning scenario, some could explicitly see the benefits of bringing into that learning scenario a digital place that could add back structure and help organise their thinking (p. 370-371). It is proposed that this affordance was apparent because of the alignment of the suggested Tech Trumps with the challenge, as prescribed by the dimensions model.

Similarly, for Spanish students who were required to organise and annotate a large body of related articles, in order to create a portfolio summarising their interpretations of a topical Hispanic issue, the ability for digital places such as Google Drive to provide both storage and annotation abilities within the same location became apparent due to the context they found themselves within, because of their specific needs or intention as derived from that learning context (p. 350-351).

For Geography students who were allocated into teams with unknown individuals, and given a time pressured high level assignment to complete, the affordances of the Team-Match software seemed clear. Its ability to scaffold team building, helping individuals develop a sense not only of their own strengths and weaknesses, but also those of their team mates, was again highlighted by the learning context they found themselves within (p. 336).

The dimensions model captures context. By focusing on key principles that define the learning scenario in question, and allowing the learning designer to rate these according to their specific design, an overall intention for the learning emerges. From an affordance perspective, this extrapolation of key learning elements provides the *context* for identifying matching invariants in digital technologies, and stimulates the *intention* within learners to ‘pick-up’ the potential affordances available.

Choosing labels from the habitat

Lave and Wenger (1991) argue that learning is situated, that it is developed through participation in a community of practice, where skills and knowledge are developed over time in specific physical and social situations. They stress the importance of language, of using the ‘right’ vocabulary, the language of the community of practice. It is proposed that part of the practical success of the dimensions model, the reason it was accepted and used in real learning scenarios to change assessment practice, is the language that it uses. It purposefully attempted to use language which was at the same time both common place, but that would also be recognised as having specific meaning relevant to those engaged in learning design. For example, the words and phrases used within the model, such as “analysis”, “critical thinking skills”, “reflective thinking” and “synthesis”, all have a common understanding, but at the same time have more specific meaning within an academic community of practice. By adopting the language of the community of practice which the dimensions model was targeted at, that same community embraced it.

Wenger argues that the language of a community of practice is a critical factor in learning, that becoming familiar with the meaning behind words, understanding how perhaps even common terms take on specialist meaning within any one community, is critical to learning. The design-based research approach has also highlighted this criticality when designing tools and techniques to align technology and pedagogy. The participatory nature of design-based research, this close connection between the design of new tools and techniques and those who they are designed for, has ensured that the language used in these tools and techniques matched that of the prospective users. This research has demonstrated not only how the alignment of pedagogy and technology can be achieved through the theory of affordances, but also how the alignment of researcher and practitioners can be achieved through the use of a common language. By ensuring that the outputs of the research use the language of each community they are designed for, these outputs have become embedded and accepted within those communities.

Defining the 'space' of learning through dimensions

Another potential reason for the success of the model may be due to the fact that it 'invites engagement', i.e. the centre of the model is blank and is designed to be actively completed, as opposed to being read passively. Those who use the model therefore have ownership of it; it becomes part of their thinking rather than that of the original designer. Users are effectively constructing their own meaning from the model, the model itself serves only as a scaffold for their own thinking. The model is a space to be used, not just read, but also to be written. It is transactional in the sense that users get something back from interaction; it provides what might be termed a dialogic space where it is possible to have a form of dialogue with the theoretical ideas of assessment which are suspended within the model, agreeing or disagreeing, proposing or countering, according to each dimension in turn. The model could be said to have an affordance in itself, it provides or furnishes a bounded and defined space to help shape and scaffold thinking.

Tech trumps to translate invariance into affordance

Although research into the use of technology in education has struggled to show specifically *how* technology might enhance learning, there seems less doubt that it has the *potential* to enhance learning. Evidence gathered over the years and summarised by the "No Significant Difference" phenomenon (Russell, 1999) and other meta-analysis (Means et al, 2009), for example, clearly shows that technology can have positive effects on learning outcomes. What seems to be missing is an understanding of how this occurs, or as Oliver (2012) summarises, a "failure to explain technology theoretically".

The Tech Trumps have proved a popular and effective way in which to highlight the potential affordances of digital technologies in a specific pedagogic context, indeed it might be said they appear to ‘explain technology’ in the context of the research. Potential reasons for the popular and practical success of the Tech Trumps are discussed, by contrasting the approach taken in this research with other potential approaches to understanding the affordances of digital technologies.

Weakness of taxonomy approaches

Chapter 3 has discussed how a common approach to identify the value of technologies within learning contexts has been to outline categories or types of affordances (e.g. Table 3.1, p. 62). But this type of categorisation of the world is potentially in conflict with the ecological perspective taken in the research, as it suggests a determinist view where technologies have fixed affordances regardless of the needs or intentions of individuals. At the heart of the ecological approach is a subtle yet fundamental shift in worldview, which suggests that rather than cognition being a purely internal information processing activity, it is a distributed activity (Hutchins, 2000). As Greeno explains:

> “The framing assumptions of ecological psychology are one form of a general theoretical stance, which can be called *situativity theory* (Greeno and Moore, 1993), in which cognitive processes are analyzed as relations between agents and other systems. This theoretical shift does not imply a denial of individual cognition as a theoretically important process. It does, however, involve a shift of the level of primary focus of cognitive analyses from processes that can be attributed to individual agents to interactive processes in which agents participate, cooperatively, with other agents and with the physical systems that they interact with.”
>
> Greeno (1994, p. 337) [their emphasis]

Chapter 7 has explained how categorisation was originally explored in the present research in order to try to align technologies with the dimensions model (p. 305), but found just this problem of multiple affordances, that digital technologies did not fit neatly into any one category. Figure 7.23 (p. 309) illustrated visually how the Blogger software, for example, could be said to have relevance to every dimension of the model for authentic assessment, and hence does not sit easily under one heading. Arguably this is not so much a problem with categorisation, but a problem with the world itself - life does not easily sit in one box. But perhaps the reason that it is so hard to place affordances into silos in this way is that affordances are, as Gibson argued, something that crosses the subjective-objective boundary. They describe the relationship between individuals and the environment. These attempts to categorise and break down affordances are arguably weak because they fail to adequately deal with the two 'ends' of this relationship, the specific context that gives rise to intention (subjective) and the specific invariant that can be detected and utilised (objective). The Tech Trumps avoid these categorisation problems by attempting to cross the subjective-objective boundary, just as Gibson had intended.

A second potential problem with taxonomy approaches is that they tend to suggest types of technologies rather than specific technologies. Laurillard's (2012a) conversational framework, for example, suggests broad types of digital technologies that might be appropriate, depending on where within the conversational framework a particular learning scenario might be placed. This can leave those wishing to use digital technologies to support their learning scenarios almost as lost as if they had no suggestion at all. For example, the recommendation for those following learning through Inquiry is to use "online advice and guidance, analyse ideas and information in digital resources, use digital tools to analyse data, compare digital texts using digital tools" (Laurillard, 2012, p. 96). Unlike the Tech Trumps model, these recommendations give little practical guidance to teachers and learners as to specifically *what* it is they should actually try and use. As has been noted in the present research by both staff and students (e.g. p. 353), and indeed in the wider literature (e.g. Bennett et al, 2012), the ability of individuals to understand the value of digital technologies in educational contexts is much more limited than is perhaps widely believed. Without specific recommendations as to which digital technology might be most effective in their work, students and teachers alike are left unsure of what to do next. By offering specific technologies that had already been aligned with the pedagogic context, digital technologies such as Scoop.it, Google Drive, Trello and Team-Match were not only used, but became embedded in learning.

Technological deterministic versus socially constructed approaches

According to Oliver "deterministic explanations of technology's role remain widespread in studies of technology" (Oliver, 2011, p. 381). A individual software is identified, e.g. Twitter, or a specific type of software, e.g. Wikis, or a specific piece of hardware, e.g. iPads, and this is then integrated into educational contexts. The expectation is that the type of technology itself has specific and measurable affordances independent of the type of learning scenario and the individuals concerned. Whilst this approach may be valid in specific contexts, it has been argued that type of educational technology research is not sufficient to provide a general framework for aligning technology with pedagogy (Jones, 2012). From the perspective of the current research, it might be said that it places affordance too heavily within the objects themselves, on the invariants that they are comprised of, and does not sufficiently recognise the importance of intention when it comes to how technologies are used by individuals in practice. Chapter 6 has argued that a flexible approach to technology use provides more opportunity for learners to find the value or affordance in digital technologies that matches their need.

These technologically deterministic approaches have an opposite in terms of socially constructed approaches. In contrast with the technologically deterministic approach which sees technology as shaping behaviour, the socially constructed approach sees technology as mutable according to need, that individuals adapt technology to use in ways which suits their specific need. This is the position that Oliver (2013) takes, for example. Indeed, Squires and McDougall (1994) note that in educational contexts technologies can be most effective when teachers and students use them in ways that the original designers had not intended. This was what the research had School A seemed to show in practice, that when students were given an open and flexible technology to use, the same technology could provide multiple affordances to suit different needs at different times. Similarly in the interventions at Exeter, academic colleagues made specific comment about the way in which students “adapted technologies they were familiar with” to suit their own purposes (p. 367). However, a strictly social account of technology fails to include the invariance within the digital environment, making any attempt to codify and plan for alignment between pedagogy and technology problematic.

The concept of interpretive flexibility, as proposed by Pinch and Bijker (1984), provides a potential way in which to blend these extremes of technological determinism versus social construction, and also has useful similarities with the concept of affordance. It suggests that however a technology may have been designed to be used, when in actual use in may be used in quite different ways to those originally intended. It proposes that technologies mean “different things to different actors” (Law and Callon, 1992, p. 24), just as the theory of affordances proposes that different individuals attend to different affordances based on personal intention or need. Interpretive flexibility suggests attempts to align technologies directly with pedagogy may be impractical, as individuals tend to find ways of using technology in unplanned ways to suit their needs. It also recognises, however, that this flexibility is limited to a certain extent by the design of the technology itself (Doherty, Coombs and Loan-Clarke, 2006). This relates to the invariant end of the affordances concept, in that technologies do have limits beyond which they cannot be interpreted, what Greeno refers to as a constraint. They are defined and have boundaries, and these can be identified by discussing and considering what is invariant about them.

From the ecological perspective, interpretive flexibility suggests that there is more that is potentially available within a digital place than the designers of that place intended, that it holds more potential affordance. Indeed it is proposed that when designing with digital technologies designers inadvertently build in invariants in multiple and complex ways for which they could not possibly outline every possible interpretation by users, and hence every affordance. This is what has been observed in practice in the current research, in that students found specific value in the digital technologies they chose to use to support their learning, above and beyond what the designers had intended. The evidence for this in the current research has been elusive, but pervasive. Adobe Visual Communicator became not simply a place to actively construct, but also to reflect. Facebook became a place to plan and organise studies, rather than just a place to networking with friends and peers. Scoop.it provided not only the ability to gather and organise data, but also supported reflection in a way which was not perhaps originally intended by the designers.

Arguably the strength of the tech trumps arises from the way in which they allow a certain degree of interpretive flexibility, blending both possible intention with fixed invariance to provide multiple potential affordances. The concept of interpretive flexibility provides a theoretical explanation for the success of the Tech Trumps, suggesting that both social construction and technological determinism combine in the digital cards and the overarching design framework. The affordances approach taken with the Tech Trumps ‘grounds’ them in practice, by requiring neither a technologically deterministic nor socially constructed position to be taken, neither objective nor subjective, they qualify the potential meaning or affordance of digital technologies in a way which makes sense to learners. This theoretical relationship between affordances and interpretive flexibility is depicted visually in Figure 8.1, below, using the affordances trinity to clarify how the different elements relate to each other.

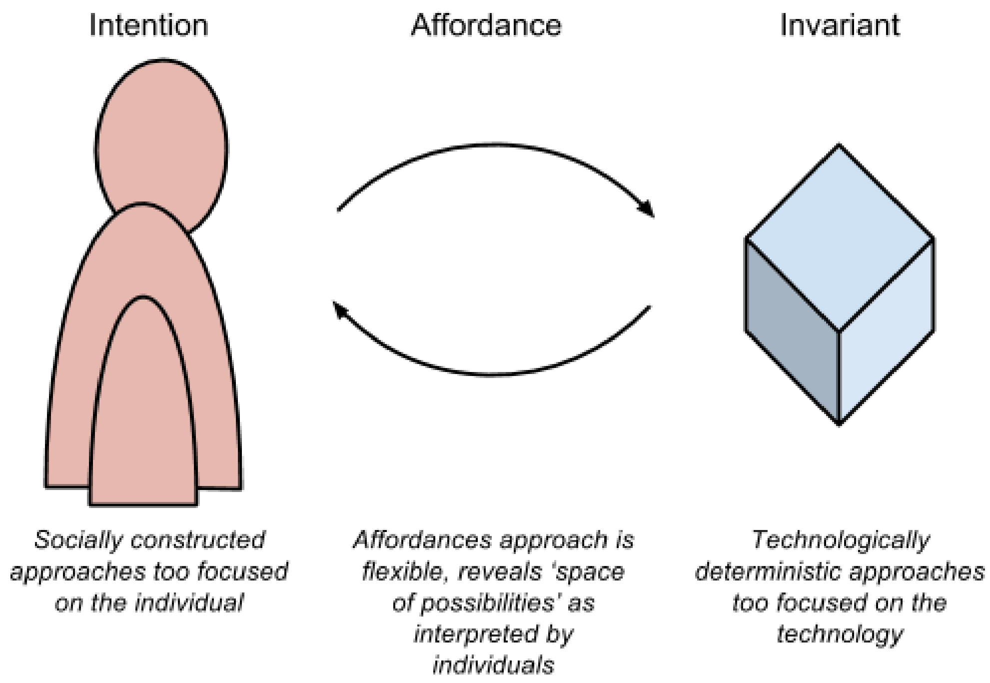


Figure 8.1 : Relationship of affordances and intepretive flexibility

Value of the ecological approach

The current research has taken what might be termed an ecological approach in order to try and answer its overarching research question, "Can the theory of affordances provide the basis for a theoretical framework through which digital technologies can be aligned with pedagogic goals?" (p. 131). Ecology can be defined as the "pattern of relations between organisms and their environment" (Merriam-Webster). The design framework as presented might be said to capture this 'pattern of relations' in the context of authentic assessment and digital technologies, and could therefore be referred to as an ecological approach to educational technology. The design framework recognises the importance of the environment at a specific point in time and space for an individual, including within the design framework a method to establish intention and hence link the subjective with the objective. Using Gibson's original language and concepts it has attempted to match the invariant *components* of digital technologies with a pedagogic model, rather than the technologies themselves, and link intention to invariant through affordance, aligning pedagogy and technology. This does not produce a prescriptive, deterministic framework, but, as Greeno explains, increases the likelihood that affordances might be taken advantage of in order to support learning:

> "The presence in a situation of a system that provides an affordance for some activity does not imply that the activity will occur, although it contributes to the possibility of that activity. Additional conditions include aspects of the activity of an agent in the situation, having to do with motivation and perception. Motivation to engage in some action is related to what the agent is doing at a more general level."
>
> Greeno (1994, p. 340)

The present work builds on these ideas on the importance of situativity and the environment, but as Chapter 4 has explained it also understands that this environment is not only the real world that is experienced, but also the digital environment. Friesen (2011) questions whether it is even necessary to debate whether one mode of learning, online or face-to-face, is better than the other, and indeed from an ecological perspective it could be argued that an individual's experience of the word is agnostic when it comes to which type of environment - digital or real - is currently being experienced. Ciolfi (2011) argues that we have reached a point in pervasive or ubiquitous computing where the digital and real now intermingle constantly:

> "... our everyday experience of the physical world is inescapably affected by the presence of technological elements, by the seeping through of the digital: from simple photo frames that display digital snapshots, to gaming platforms that allow users to play through natural gestures, to advanced smart phones, nearly every space we live in - be it work, home, travel or pleasure - is characterized by a digital layer."
>
> Ciolfi (2011, p. 7)

Our habitat is an increasingly blended environment, with the digital and the real in some cases blending seamlessly into each other. New developments such as Google Glass are perhaps the extreme of this curve, where reality is augmented with digital objects overlaid onto a view of the real environment. But there are other, more subtle indications that the digital is increasingly being embedded into the real, and in a bi-directional sense. Fitness trackers, for example, 'watch' us as we go about our daily business and are paying attention to our own movements and habits as much as we might be paying attention to them. There are *transactions* going on invisibly around us.

The notion of a broader 'technology' that assists learning may in itself be inherently flawed due to the lack of definition within the word technology. As Arthur (2009) and others have argued, the world technology has multiple interpretations, it is a very broad term and hence to use it in specific ways can make it meaningless. It is perhaps akin to populist fallacies such as blaming 'the people' or 'the society'. By recognising the broader ecology of learning, and including within it digital technologies as distinct places or habitats in their own right, the design framework as presented seems effective in providing one way in which to align pedagogy and technology. It is proposed that this is at least in part due to the ecological approach that has been taken, recognising digital technologies not simply as tools, but also as places.

Design methodology

> "A design methodology is a general design procedure. Like a design framework, it is prescriptive. However, a design methodology provides guidelines for the process rather than the product. A design methodology describes (a) a process for achieving a class of designs, (b) the forms of expertise required, and (c) the roles to be played by the individuals representing those forms of expertise. A design methodology typically lays out a sequence of tasks, describing the objectives, processes, and participants for each step."

Edelson (2002, p. 115)

The design framework as presented has been used internally at Exeter multiple times, both by the author and by academic colleagues, since the current iterations were completed, but it also been highlighted during the research by several participants that the underlying approach has the potential to be modified in order to suit different contexts. Indeed, two other institutions in the UK are already known to have adapted the model for their own use, in one case reducing the dimensions to four, in another case reworking the dimensions themselves to suit their own specific context. Potentially therefore what the domain theory and the design framework offer together is a design methodology, a way of prompting thinking in general regarding learning design and the alignment of digital technologies, which could be adapted and applied to other contexts. By extracting the underlying relationship between elements of the previously discussed design framework, the trinity of affordances which comprises intention, invariant and the transactional ‘space of possibilities’ of affordance, a generic design methodology is proposed that arises directly out of the current research.

What learners seemed to attend to in practice in the current research were the individual components of a technology which had value for them, those aspects which were invariant and could be returned to again and again in a consistent and reliable manner. This might be the timeline during work in School A, the tile based curation available in Scoop.it, or the ability to comment and discuss in Facebook. This selective attention, as Gibson termed it, seemed to be driven by intention. The problem the design faced was how to isolate and make explicit this link between invariant and intention. The questioning technique that was devised lies at the heart of approach taken, but simply referring to this as a questioning technique perhaps undermines the central role it played in the research. Arguably what this questioning technique itself provided was an opportunity to engage in a dialogue about the value of technologies given a specific context. The dialogue was what identified the affordances central to the ecological approach taken, and it was in the dialogue that potential affordances emerged. The questioning technique might be said to have opened up a dialogic space within which to explore the value of the technologies. The creation of a dimensions model to capture a specific pedagogical intention focused that dialogue down so it was bounded and hence productive, suggesting that a different dimensions model, capturing a different pedagogical intention, might similarly simulate the necessary dialogue to lead to alignment of digital technologies with a pedagogical context.

Design methodology process

By analysing how the current research created the products that seemed successful in use, a process has been extracted, and is shared here in order to propose a design methodology for aligning pedagogy and technology. Following Edelson's (2002) guidance (i.e. to lay out a sequence of tasks, and describe the objectives, processes, and participants in each case) key elements from the design narrative within the current research are extracted and isolated, producing a prototype process consisting of three tasks. The objective of each task, the process itself, and the participants required are listed in Table 8.1 below.

Task	**Objective**	**Process**	**Participants**
1. Create dimensions model summarising context	Clarify pedagogic intention, and hence focus the intention of learners	Using the available literature, search for principles that summarise your specific educational context. Select simple words or short phrases that summarise these principles, and arrange them into a radar or spider model. Add richer descriptions as guidance for each, generally speaking the underlying principle itself, rewording as necessary in order to actively prompt thinking.	Academics, researchers, lecturers, students, educational developers

2. Specify potential digital technologies	Create a subset of potential technologies from those commonly available, given institutional and other constraints	Select from the pool of technologies available to learners at your institution a list which you know the majority of those learners would be able to engage with. In some cases this may be limited by institutional rules. Expand complex technologies into their components, for example a VLE should not be included as one entity, instead extract the functional aspects which comprise it.	IT experts, Learning technologists, E-Learning / Technology Enhanced Learning specialists
3. Rate digital technologies in the context of the model	Use the ‘questioning’ technique to align the invariant components of the identified technologies against each dimension of the model	Using the principles as a basis, write questions using the language of affordances in order to prompt thinking, e.g. “Does the technology provide ...”. Use small groups to create a dialogue around each technology, and rate them against each dimension in turn.	A blend of academics, researchers, lecturers, students, educational developers, Learning technologists, E-Learning / Technology Enhanced Learning specialists

Table 8.1: Potential design methodology

Following this design methodology should allow a new design framework to be created that brings together intention and invariant, which then uses a dialogic process to identify the transactional ‘space of possibilities’ of affordance needed to align them. This process matches the trinity of the theory of affordances as depicted below in Figure 8.2:

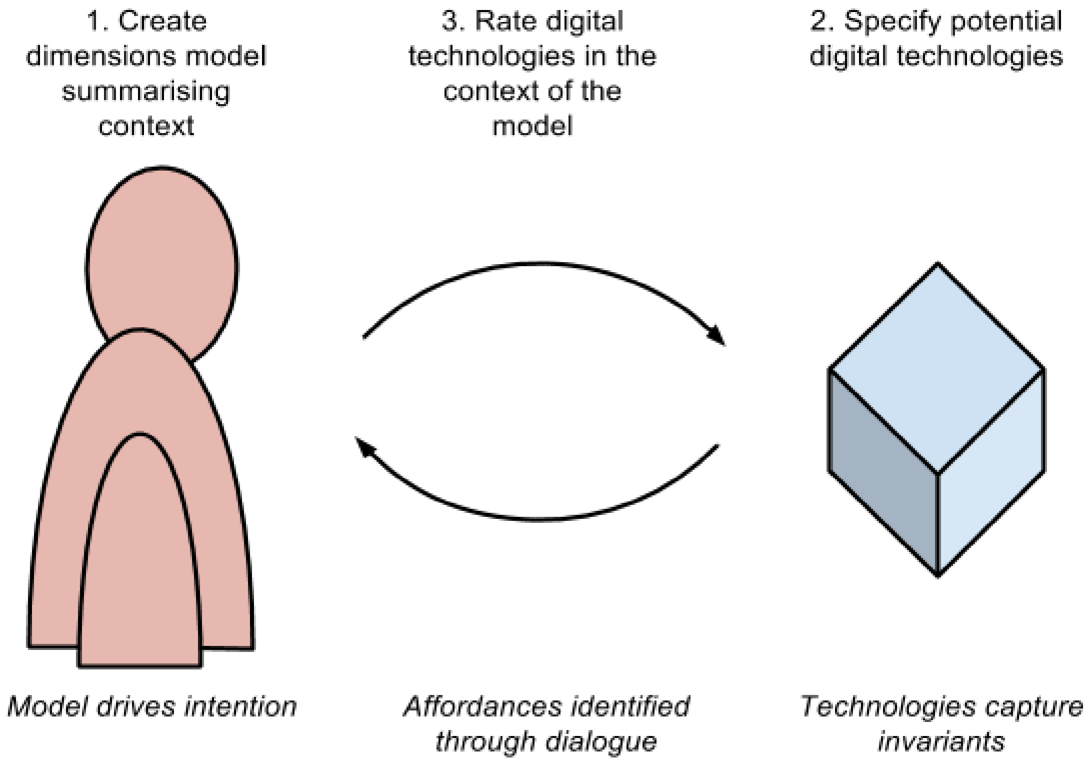


Figure 8.2: Alignment of design methodology with affordances theory

Although based on the research findings, this design methodology remains at present a theoretical extraction of the key aspects of the design-based research approach as outlined in the design narrative. Chapter 9 explores the concept of this design methodology further, discusses two examples putting this design methodology into practice at Exeter, and suggests future work to develop the concept.

The design-based research approach

Value of interim reporting

Chapter 5 has highlighted that a key stage in design-based research is interim reporting:

> “Finally, it is important to report design-based research in the forms of in-progress reports, a series of interim reports, journal articles, and books because

it is likely to evolve over time."

Instructional Technology PhD students at the University of Georgia (2006)

The current research has met this requirement comfortably. Three internal reports have been prepared for a project steering group, three interim reports have been written for the funding body, one final report in the form of an institutional story, one evaluation report, four conferences have been presented at, multiple internal presentations have been prepared and delivered, and one journal article has been published - winning a best paper award (Osborne, Dunne and Farrand, 2013).

From the perspective of the current research, the reporting aspect to the design-based research process is one that might easily be overlooked, but to do so would be an oversight. Stepping back from the research on a regular basis in order to analyse, evaluate and synthesise progress has been invaluable throughout the research process. Indeed, Chapter 7 has recorded how a crucial step in the design process - that of moving from rulers/continuums to the design model as a radar or spider diagram - occurred as a result of the interim reporting of the design.

Whilst Reeves (2005) and others do suggest that interim reporting of results is an important part of the design-based research approach, it is perhaps not always easy to see the value of this aspect out of context. Perhaps the use of the word 'reporting' is misleading, as it is in the conversations that are a product of reporting that the true value reveals itself. In my opinion, the value of these conversations with peers cannot be overestimated. In all probability the conversation that took place at the conference in 2012, which inspired the radar diagram and hence broke a deadlock with academic participants, was the final cycle in a long line of cycles of micro iteration which led to a macro iteration in terms of the design process. This shifted the entire focus of the design to a different shape, one that would ultimately prove to be crucial to the success of the design framework in helping to align pedagogy and technology.

Importance of defining success criteria

The specific design-based research process used in this thesis has been largely based on the work of Instructional Technology PhD students at the University of Georgia (2006), who produced a nine step plan (Table 5.2, p. 132-133) specifying how design-based research might be planned, or at least how it might begin. These steps have been invaluable in helping to frame the overall process.

Whilst these steps have been helpful in beginning the design-based research process, and indeed in helping to frame its ongoing progress as depicted in the DBR spring module in Figure 5.3, one aspect they do not include is when to stop design-based research. As Dede (2004) has observed, knowing when to stop design-based research can be problematic. Dede suggests defining success criteria early on in the overall research process provides credibility and also stops “design creep” (Dede, 2004, p. 109) where the objectives of the overall research become unbounded and unmanageable.

The present research adapted work by Herrington et al (2007) to provide success criteria, providing three clear objectives: to produce scientific outputs in the form of design principles; practical outputs in the form of designed artefact(s); and societal outputs in the form of the professional development of participants. It is proposed that this step of defining success criteria should be added to the nine steps as provided by the Instructional Technology PhD students at the University of Georgia (2006), and strengthens the overall process by ensuring clear criteria for success are set out from the beginning of the research process.

Summary

This chapter has explored what the findings from the research at School A and the

University of Exeter might mean, when related to the wider literature and the research questions. Using Edelson's trio of potential contributions that design-based research might make as lenses through which to analyse the findings, three main contributions are proposed: Firstly, a redefinition of affordances as transaction possibilities, which recognises that digital environments can have active impact on learners just as much as learners can have active impact on their environment; secondly, a practical design framework based on this understanding of affordances as transaction possibilities, which aligns a specific pedagogic scenario with the digital technologies that have the potential to support that scenario; thirdly, a potential design methodology generalised from the design framework, which might allow for the broader alignment of a learning scenario with the digital technologies that have the potential to support that scenario. Reflections on the design-based research process are also offered, including the value of regular reporting and the importance of defining success criteria.

The next chapter summarises the research as outlined and discussed in this thesis, and explores what it might contribute to the wider educational technology community. It also explores the limitations of the study, and proposes areas for future work.

Chapter 9: Conclusion and Implications

> *"The greater danger for most of us lies not in setting our aim too high and falling short; but in setting our aim too low, and achieving our mark."*
>
> Michelangelo, Italian Sculptor

Introduction

Previous chapters have explored whether the theory of affordances can provide the basis for a theoretical framework through which digital technologies might be aligned with pedagogic goals. Through a design-based research approach, models, tools and techniques have been developed and tested, which appear effective in providing this alignment. This chapter summarises the key points raised in earlier chapters, and describes the contribution the work has made to the challenge of how to utilise digital technologies effectively within learning contexts. It outlines the limitations of the study, discussing the potential boundaries of contribution. It concludes by suggesting new directions for future work based on findings from the present research, which may have the potential to reveal new ways to support learning through digital technologies.

The context of the research

This thesis began by discussing how research into educational technology over more than 30 years has been coloured by on the one hand a deeply held belief that technology has the potential to transform education, and on the other hand a lack of evidence to show this transformation in practice. Whilst many discrete examples do exist of technology having a positive impact on learning through “augmenting and connecting proven learning activities” (Luckin, 2012, p.63) attempts to create an overall framework to understand exactly how technology might be applied to in order to transform learning have struggled to gain popular acceptance. It has been suggested that this problem may in part be due to a “failure to explain technology theoretically” (Oliver, 2012, p.1), that there is no effective framework within which to think about technologies in an educational context, which could help to explain why they might succeed, and why they might fail. One potential way of explaining the value of technology in pedagogic contexts that has been proposed is to use Gibson’s theory of affordances.

This thesis has explored the history of the theory of affordances in Chapter 3, and the challenges it presents when used in educational technology contexts. The use of affordances as the underlying theory to align technologies with a pedagogic approach may be questionable (Oliver, 2005), and there is certainly much debate over the pros and cons of the term from an educational perspective, but some have suggested that the theory still has much to offer (Hammond, 2010). Oliver’s (2005) critique of affordances remains the most robust and comprehensive argument against its use in educational technology contexts, but arguably the points that it raises against affordances are undermined by the commonplace understanding of affordances as ‘action possibilities’. This term is now widely seen as synonymous with affordances, but analysis of the literature has revealed no connection between this definition and Gibson’s original conception of the theory. Chapter 3 has suggested that a misappropriation of the term has arisen due to its adoption in multiple fields, especially in the field of Human-Computer Interaction. It proposes that understanding affordances as ‘action possibilities’ limits its usefulness in educational contexts, as it fixates technologies as tools, ‘things’ to be prodded, pushed or pulled. The current research has explored how a return to Gibson’s original definition of affordances as what something “provides or furnishes”, together with a re-focus on the core ideas of intention and invariant, may allow affordance to be used as a design tool to align pedagogy and technology.

Chapter 4 updated Gibson for the digital age. Recognising that the original theory of affordances was conceptualised within a broader ecological approach, that included within it the environment as a key actor, it discussed the question ‘what is this digital environment?’ when considered from a Gibsonian perspective. It has proposed that digital technologies create digital environments, digital spaces and digital places, within which affordances can be discovered and utilised. Specifically it proposed that digital technologies cannot only be conceived of as tools, but also as places, potential habitats.

The research approach

Reeves has argued that lack of progress in educational technology research may be directly related to the approaches that have been taken, that classical approaches to research are too formulaic and structured to uncover the rich complexity of digital technology use in practice (Reeves, 2006). This led to the development of a new type of methodology, design-based research, which has gained a firm foothold within the educational technology research community (Parker, 2011). Chapter 5 has outlined how this design-based research approach attempts to understand the wider system of learning, actively intervening in research settings in order to change them and study the effects of change, and hence is a good match for the ecological approach of Gibson. The main aim of the research is defined: Can the theory of affordances provide the basis for a theoretical framework through which digital technologies can be aligned with pedagogic goals?

Chapters 6 and 7 have presented design narratives that explain how the design-based research was implemented in practice, how an initial design framework linking intention in the individual and invariant in the world through the transactional ‘space of possibilities' of affordance was proposed from research at School A, and how this initial design framework was developed and completed through research at the University of Exeter. The design-based research approach taken has proved central to the dual challenge of developing theory through educational interventions, whilst at the same time building practical tools and techniques to positively impact learning scenarios. Theory has driven design, but at the same time this theory has been kept 'hidden' from participants, enabling them to take advantage of practical products of immediate benefit to their own personal challenges. This is arguably the key strength of a design-based research approach, the ability to develop new theory contributing to knowledge, whilst at the same time producing practical products to develop professional practice and improve the experience of learners.

Summary of contribution

A design framework for aligning pedagogy and technology

From a purely practical perspective, the findings from the research suggest that the design framework tentatively introduced in Chapter 6, and enhanced and completed in Chapter 7, is effective in its aim of aligning pedagogy and technology. By isolating pedagogical intention at one end of the framework, and potential technological invariants at the other end of the framework, bringing these together using the questioning technique of affordances, specific digital technologies have been successfully adopted by learners to support their studies. Whether Team-Match to support group collaboration and teamwork, Scoop.it to support individual data analysis and synthesis, or Trello to support planning and evaluation, multiple examples have shown the successful alignment of pedagogy and technology. It might be argued that learners would have intuitively found the right technology to support their studies without this framework, and indeed some evidence suggested that use of social networking sites such as Facebook did appear spontaneously and productively, but other evidence from the current research suggests this was not the norm. Learners have reflected on their own lack of understanding of the value of digital technologies in context, and academics have been surprised at the lack of digital literacy of their own students, suggesting that learners will not implicitly select digital technologies that have the potential to support their learning. The research aimed high, and did not perhaps gather as much evidence of impact as I would have preferred. Nevertheless, following the post-positivist approach as outlined in Chapter 5, it is proposed that the data presented does provide sufficient warrants of effectiveness for the design framework.

Chapter 7 has noted how the production of artefacts is a key part of the design-based research approach; Kelly (2004) suggests that the adoption of any products could potentially be seen as a test of the success of research undertaken in this way. From this perspective, the research might also be seen as successful. The design framework has now been adopted centrally at Exeter, embedded into the institutions professional development courses in order to support new academics, and is being used by individuals within specific disciplines who can see its benefit in their own contexts. Furthermore the paper based version of the dimensions model has now been turned into a web app, or web based application, which provides an interaction version of the practical tools that have been designed, made available to all staff at the University of Exeter.

Similarly the tech trumps have been adopted centrally by the University of Exeter, in the form of another web app embedded within the Exeter Learning Environment (ELE, the University's Virtual Learning Environment), to support the development of staff and student digital literacy. This web app is now receiving thousands of visitors per month, and perhaps most tellingly analytics data reveals that returning visitors, i.e. individuals who make repeat visits to the app, spend much more time engaging with the different cards available than new visitors. This suggests that they are finding specific value within the tech trumps.

At least two other UK Universities are known to have taken up the products of the research and adapted them to their own needs.

The criticality of context

Findings also provide suggestions as to *why* the design framework is effective in practice. The underlying theory of affordances which has driven design of the framework suggested that individuals pay attention to affordances which are relevant to their needs or intention at a moment in time. Affordances are contextual. A significant contribution of this thesis to understandings of affordance is this criticality of context: affordance is a relational concept, and that relationship is framed by personal context. Oliver argues that Gibson's concept of affordance "allows us to talk about technology as part of the environment, but not about minds" (Oliver, 2005, p.412), but the current research has argued, and explored empirically, the notion that affordance is entirely about minds, in the form of the intention of teachers and of learners.

By capturing pedagogic intention first, and then connecting learners with digital technologies that match this intention later, affordances with the potential to support that intention became apparent. Hence some Geography students saw the value of Facebook, and how it could form digital bridges between team members, extending opportunities for dialogue and engagement. Similarly some Spanish students adopted technologies such as Scoop.it and Google Drive, embedding them into their learning to build an extensive portfolio, harnessing what the digital place could provide for them. Some Psychology students could see the value of Trello to structure a complex series of tasks over an extended period of time. Not all students adopted all technologies, some found their own methods or perhaps chose non-digital support, but those who did choose technologies as suggested by the design framework appear to have benefited as a result.

Digital technologies as digital environment

This leads to the next contribution from the findings, the notion of digital technologies as digital spaces and places. For those Geography students, Facebook was not simply a tool to write, but a place for building relationships and receiving peer feedback on progress over the course of the module. Scoop.it was not simply a curation tool, but a place for pooling and contrasting different perspectives on a topic over an extended period of time. Trello was not just a replacement for a checklist or notepad, but a digital mirror of current tasks and priorities used over many weeks.

Conceptualising digital technology as tools limits what can be achieved with them to actions; tools do not take actions themselves, they are what is acted upon. Places, in contrast, contain other active elements within them, they are active spaces which change over time, and hence they can act on those within them. This allows the place to provide something back to the learner, as opposed to the learner simply doing something to the place. The positivistic change in the world caused by actions with digital tools is replaced by the personal interpretive change within the individual as a result of the transactions possible with digital places. The action possibilities approach to affordances which focuses on technology as tools becomes the transaction possibilities approach which focuses on technology as place; technology becomes something that can give back, rather than just something that is acted upon.

Affordance as transaction possibilities

This leads to the final contribution of this thesis, the notion of affordance as transaction possibilities. Transaction has been a strong thread running through this thesis, and it has been argued that if affordances are understood as transaction possibilities, instead of the commonly understood action possibilities, they can be used as an effective design tool for aligning pedagogy and technology. Understanding affordance as transaction possibilities open up the affordances concept, and brings it back to

Gibson's original notion of what something in the world "provides or furnishes".

Chapter 3 has explored the origin of the definition of affordances as action possibilities, suggesting that it was in the field of Human Computer Interaction or HCI where the popularity of this definition seem to have taken hold. In the HCI world of theoretical design, which many years ago was my main work, it can be challenging to imagine how the many hundreds or thousands of users might react to an interface once released into the wild. Affordance provides a thinking tool, a way of asking yourself "what would a user make of this element of my design?" ahead of time. But this is always in context; there is always a designed digital place which the potential affordances connect to, which drives intention. There are also people to design for; interface designers often use personas to help them imagine what a user might make of their designs, a collection of invented individuals with differing characteristics designed to challenge thinking about how they would react to a design element. By using personas a rich picture of context can emerge. But interface designers are interested in what people can do, what actions they can take to achieve a goal, e.g. buying a product, applying for a loan or catching up with the news. Learning designers are surely much more interested with how experiences *change* individuals.

The current understanding of affordances as action possibilities is undoubtedly useful, capturing as it does the active nature of the learner, focusing on what they can do in a particular situation. But the situated perspective of learning suggests that activity is only half the story, it suggests that the environment also acts back on the individual at the same time in a positive manner:

> "... cognition is widely distributed across the environment, both social and physical. And we suggest that the environment, therefore, contributes importantly to indexical representations people form in activity. These representations, in turn, contribute to future activity."

Brown, Collins and Duguid (1989, p. 37)

Activity in the environment changes that environment, and that in turn changes the individual. This is the importance of the notion of transaction possibilities, it expands the affordances concept to take into account this key understanding of situated learning, and recognises affordance as not simply 'what can I *do* in this environment' but more importantly from a learning perspective 'what will *happen* when I do this in this environment'. When understood as transaction possibilities, affordance becomes a hypothesis for the consequences of action, tested in everyday experience, and a potential hinge on which learning is predicated.

Limitations of study

Any research study has limitations, and it is important to try and identity these in order to tease out potential wider application of the research (Bryman, 2013). Potential limitations identified for the present research are discussed below.

Purposeful selection skewing results

Research at both School A and Exeter used a technique of purposeful selection, the selection of "individuals, groups and so on according to their (expected) level of new insights for the developing theory." (Flick, 2006, p. 126). At Exeter in particular, there was an attempt to find participants who were already engaged in some form of authentic or employability related learning, supported by technology, by selecting modules for inclusion that mapped pre-defined keywords as explained in Chapter 7. Arguably such a purposeful selection procedure might skew the research, by only working with participants who were highly digitally literate or who were already using digital technologies that were closely aligned with their teaching.

In practice however findings have shown that both academic and student participants were not found to be particularly digitally literate, and indeed there was a wide range of skill levels when it came to using digital technologies. Academic colleagues for all four of the major iterations discussed in Chapter 7 expressed their lack of digital expertise, and some explained that one of the reasons for becoming involved with the research was the opportunity to explore the potential of digital technologies to support their students. As a consequence there is unlikely to be undue skewing of the research data due to the technique of purposeful selection. Nevertheless, further use of the products in different contexts would help to strengthen the warrants as presented.

Limited context restricting applicability

The bulk of the evidence to support findings, and hence the wider contributions of the research, have come from the research at Exeter. Only four iterations from that phase of the research have been discussed in detail, and although these have covered different student levels, different disciplines, different students and different tutors, they still only represent a relatively small example of successful practical alignment. It might be argued that whilst the data using the design framework in these cases suggests alignment was successful, such success might not transfer to other contexts, especially without guidance and intervention.

This seems a valid concern, and indeed it would have been preferable to continue gathering more examples of practical use, given more time to research. Potentially I underestimated the amount of effort it would take to engage at a rich enough level with so many iterations simultaneously. Nevertheless the wider independent take-up of both the dimensions model, and the tech trumps, would suggest that the design framework does provide a valid model. Whilst only four iterations have been documented here, many other designs took place and a selection of dimension models from these iterations has been included in Appendix E5. Many more designs have been created at various conferences and workshops which it was not possible to capture, and as has already been mentioned two other institutions are known to have adopted the design framework for their own needs. The Tech Trumps web app, now embedded in Exeter's Virtual Learning Environment, continues to be popular with over 3,000 users in its first two months since being released. It remains especially popular with return visitors, suggesting that learners have independently found value in what it provides.

Lack of rigour of the design-based research approach

As has already been referred to on several occasions, design-based research is a relatively new methodological approach. Indeed, some might argue that it is not even a methodological approach, more a collection of methods (Kelly, 2004). It is, however, undoubtedly popular within the learning sciences community (Collins, Joseph and Bielaczyc, 2004), and has proved to be a powerful way in which to structure the current research. The question is whether or not design-based research is rigorous enough to make the strength of claims or warrants that have been put forward as contributions to knowledge in this thesis.

One way in which to answer this challenge is to explore the impact that the research has had on practice. Kelly (2004) argues that by focusing on the practical impact of design-based research the true value can be understood, and the findings from the current research would suggest that the impact on participants was both positive and widespread. Both students and academics reflected positively on the modules as described, which can be seen in not only in the data gathered, but has also in the MACE (Module And Course Evaluation) data routinely gathered at Exeter. Students for module PSY1301, for example, stated that the authentic assessment designed for that module as a direct result of the use of the design framework was the best aspect of the module.

Dede (2005) suggests that traditional approaches to educational technology research often produce either important sizable effects supported by thin evidence, or mildly statistically significant results for trivial problems. They state that in contrast design-based research provides the opportunity “to create important, theory-based educational interventions of sizable effect and reasonable plausibility and generalizability” (Dede, 2005, p. 3). It is suggested that the findings as presented are reasonably plausible given the data, and the take-up in other disciplines would suggest generalizability. From that perspective whether or not the design-based research is rigorous is perhaps a discussion beyond the remit of this thesis.

Researcher skills

A final potential limitation is the impact of the researcher skills on the research process. Care has been taken to avoid researcher bias where possible, mainly through regular reporting and other everyday project management techniques, but this will undoubtedly be a factor at some level. It has been proposed that researcher bias is even necessary in design-based research, inasmuch as the close personal involvement with participants requires emergent thinking from the researcher to inform and shape the research process (Design-Based Research Collective, 2003), so this limitation is not perhaps unduly concerning.

What is perhaps more concerning is how personal skills are developed during the research process. Chapter 1 has outlined how I started this process as a web designer, not as an educational researcher, and although my skill and knowledge in both research and education has undoubtedly grown, with hindsight there are aspects to the research as described which it may have been better to carry out in other ways. The research has certainly transformed my understanding of the field of educational technology, and findings suggest that the impact of the research has helped to develop the professional practice of participants, but being aware of how much I know now that I did not appreciate when I began, makes me cautious about how much I might know tomorrow that I do not know now. As such the ideas presented in this thesis are almost certainly likely to change, and can only be warrants for the best I can offer today. Nevertheless it is hoped that some of the contribution as proposed in this chapter will help to provoke further useful thinking, and prove of some value to the wider educational technology community for which they are intended.

Future work

The final section of this thesis discusses potential directions for future work based on the findings from the current research.

Exploring ecological approaches to educational technology

This work has focused on re-exploring the theory of affordances, and whether it could have value in providing a theoretical framework for aligning digital technologies with learning scenarios, but that has always been framed within a wider ecological approach to digital technology. It has been argued that digital technologies should be viewed not simply as tools, digital objects to be pushed or prodded, but as providing a digital environment that exists alongside the natural environment that we are familiar with. To use the language of Gibson, digital technologies provide new mediums, substances and surfaces that together create this new digital environment, a separate series of places that we can move into, through and around, meet others, create objects, and leave our marks within.

Mirroring Gibson's own experiences in moving from the laboratory to field based observation and research, the author has found immense value in considering digital technologies as spaces and places in their own right, which has led to different ways of thinking, prompting different questions, about the potential of digital technologies within learning scenarios. They become parallel worlds to be dipped in *to* and out *of*, alongside real world experiences, potentially augmenting and extending those real experiences in real time. Specific digital 'tools' may be used along the way, but - crucially - the space/place itself has value above and beyond a simplistic tool metaphor. It is suggested that more research into these ecological conceptions of space/place might help to better understand the value that they provide, and how the design of these spaces and places itself impacts both teaching and learning. Gibson's notions of medium, substance and surface in particular may provide a useful model to frame thinking about the nature of digital technologies.

Identifying unique affordances

This research has focused on affordances which might be considered as obvious or normal, support for collaboration, peer review, or data analysis perhaps. Some aspects of the research however have suggested that digital technologies might provide unusual affordances, perhaps even unique affordances.

Any new environment provides, from an ecological perspective, new habitats and new niches and therefore has the potential to provide new affordances (Gibson, 1979). If we travel abroad, for example, we might come to explore or observe new customs, foods, methods for performing skills, affordances in practice if you will, that through experiencing or observing we could learn ourselves and would therefore become an affordance for us. These affordances would be based, however, on existing affordances. For example, experiencing chopsticks for the first time may seem like a totally new experience, but it will be based on existing affordances that we are familiar with - the properties of wood or plastic, its rigidity, the level of force we can exert, the amount of weight to expect, etc. We may create new things in the natural world, but they will always be based on things already present in the natural world. As Gibson puts it:

> "This is not a new environment - an artificial environment distinct from the natural environment - but the same old environment modified by man. It is a mistake to separate the natural from the artificial as if there were two environments; artefacts have to be manufactured from natural substances."
>
> Gibson (1979, p. 130)

A point rarely if ever discussed, however, in the literature of affordance and its relevance to technology is that Gibson was writing in a pre-PC world, and had little or no concept of what computers might come to be. Computers for popular as opposed to specialist use, typified by those such as the first mass produced computer from Apple introduced in 1977, the Apple II, were still limited to type based displays - the graphical user interface did not enter any widespread use until the early eighties. The ‘Theory of Affordances’ was written for a world without the home PC, without the Internet, and without apps, wikis, blogs and all that has since been developed. Gibson published his most complete summary of his thinking, ‘The Ecological Approach to Visual Perception’, in March 1979, but died later that same year so never had an opportunity to revisit his concept of affordance in this new world of personal computers, tablets and smartphones.

If these personal computers, tablets and smartphones - these digital technologies - are considered as providing a digital environment, one of the potential consequences of this position is the possibility of not just new affordances, but unique affordances. We are no longer creating places and tools within the natural world, but within a totally new environment with new rules and new ways of behaving. Chapter 4 has explored Gibson’s conception of medium, substance and surface as the building blocks of the world of affordances, but as explained these are all ‘real’ things, material objects that we are familiar with and which have existed for millennia. The digital environment, in contrast, consists of new mediums, with new substances, creating new surfaces. Although we tend to spend a great deal of effort to simulate the real world within digital environments, in order that these new places will be intuitive and easy to use, we may perhaps be unwittingly side-lining the most important aspect available to us within these new digital environments - the potential for new affordances. Our predisposition for replicating objects and experiences from the real world using digital technologies, to use technology to simulate paper, pen, etc., allows us to recreate real world experiences, but perhaps digital technologies true potential lays in creating new experiences that would not be possible without the technology. By investigating and designing into learning experiences unique affordances provided by digital technologies, we may yet discover unique learning potential that has until now remained dormant within us.

For example, within the present research situations have repeatedly presented themselves which suggest that the time-space underlying a new digital environment is acting in an unusual and radically different manner to that experienced in real space. This unusual time-space, or to use the language of Bahktin (1981) this chronotope, appears stable and useable, and it is suggested that through a better understanding of the chronotope underlying a specific digital environment, new affordances might be discovered. A particularly interesting phenomenon that was observed during the research was the manner in which certain digital technologies appeared to provide a space for rapid and iterative reflection and progression, which appeared to support equally rapid progression in thinking. This effect has been described as 'mirroring', where the digital technologies provided a particular chronotope that not only reflects thinking but does so in real time, and with the corresponding ability to rapidly create/destroy digital representations of thought. The term 'mirroring' attempts to summarise the real time, personal, reflection of thinking, which can lead to this rapid cycle of progression in thinking. It is suggested that this concept of mirroring may typify the type of ecological, space/place influenced, unique affordance that digital technologies might be able to provide. As such, further research to explore mirroring and the impact of different chronotopes on learning would be a natural next step from this thesis.

Developing the design methodology for aligning pedagogy and technology

Chapter 8 used Edelson's (2002) trio of potential contributions that design-based research might make in order to frame discussions, and introduced a potential design methodology extracted from the design-based research process as the third part of this contribution. It is suggested that the design methodology that emerged from the domain theory and design framework, which provides a generalised solution for undertaking design-based research where the objective of that research is the alignment of digital technologies with a specific pedagogical context, needs further development.

This development has already started. The design methodology has been put into practice in two of my own projects, where I have been personally referring to it as the APT design methodology, shorthand for the Alignment of Pedagogy and Technology. The word apt is defined as ‘something that is appropriate or suitable’, but tellingly only ‘in specific circumstances’”, hence it has a natural synergy with the notion of affordances; it suggests a relational approach. Something that is apt is only apt within a context, an apt response to a suggestion, or an apt tie for a suit, or perhaps an apt wine for a meal. Similarly the design methodology aims to find which digital technologies are most ‘apt’ within a specific pedagogic context, helping learning designers to better understand the value of digital technologies for their specific context.

I have created and completed one design framework in order to support the review of Virtual Learning Environments (VLEs), and a second design framework is currently in progress which should help to understand the broader picture of assessment and feedback practices, and how digital technologies might be aligned with these practices. In these two examples, discussed below, the technique has shown promise in helping to provide alignment between a pedagogic context and the potential value of digital technologies to support that context.

Example 1: VLE Review

In the first instance, a review of the institutional VLE was required, and rather than carry out a functional comparison which might be the typical solution to this scenario, it was decided to apply the design methodology as outlined to provide a more robust and research based evaluation.

The first step of the process (Table 8.1, p. 405-6) requires a suitable literature based framework from which principles can be extracted. It was decided to use the Community of Inquiry framework for this purpose (Garrison, Anderson and Archer, 1999), as this is a mature and relatively well tested and researched framework. The main elements of the Community of Inquiry framework are three presences: social, cognitive and teaching, as listed in Table 9.1.

Social presence	**Cognitive Presence**	**Teaching Presence**
The ability of participants to identify with the community (e.g., course of study), communicate purposefully in a trusting environment, and develop inter-personal relationships by way of projecting their individual personalities. (Garrison, 2009)	The extent to which learners are able to construct and confirm meaning through sustained reflection and discourse (Garrison, Anderson, and Archer, 2001).	The design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes (Anderson, Rourke, Garrison, and Archer, 2001).

Table 9.1: Community of inquiry presences

These presences are most commonly represented as three interlinking circles, as in Figure 9.1:

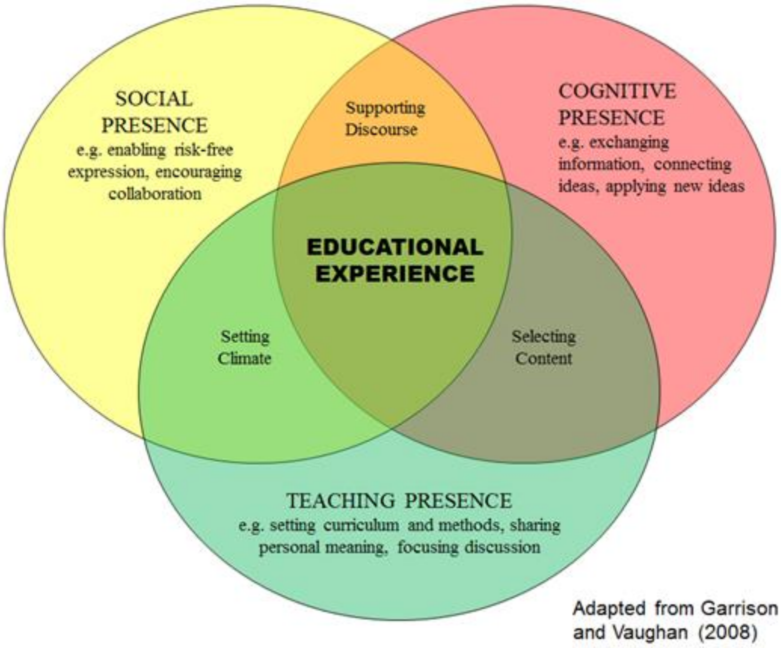


Figure 9.1: Community of Inquiry presences

Interestingly from the perspective of affordances as transaction possibilities, Garrison and Anderson also consider that transaction is a crucial part of the overall educational experience:

> "A critical community of learners, from an educational perspective, is composed of teachers and students *transacting* with the specific purposes of facilitating, constructing, and validating understanding, and of developing capabilities that will lead to further learning. Such a community encourages cognitive independence and social interdependence simultaneously."
>
> Garrison and Anderson (2003, p. 23) [my emphasis]

The next step in the process is to list technologies within the constraints of the learning scenario in question. In this case this was done by extracting from the (4) VLEs in question common functions, e.g. Chat, Discussion Forum, Assessment etc.

The final step in the process is to use the questioning technique to ascertain the affordances in each case, with question derived from each presence in turn. Space precludes a complete description of the process, but this design framework eventually allowed not only for a quantitative comparison of VLEs based on the Community of Inquiry research, but also a visual depiction of the relative merits using three circles to represent their respective strengths in relation to the Community of Inquiry framework. An example of this is depicted in Figure 9.2, below:

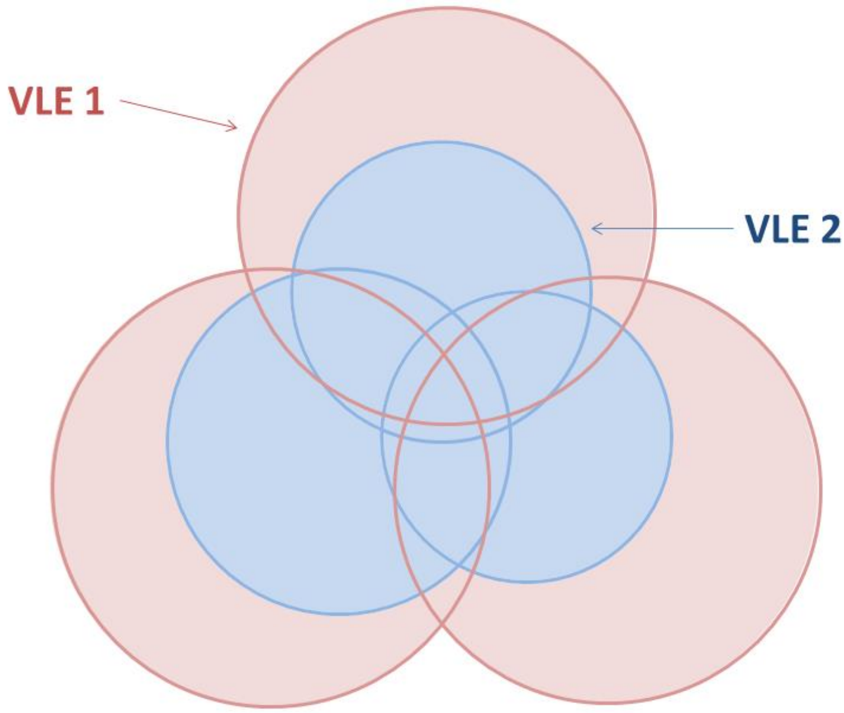


Figure 9.2: Two VLEs compared using the new design framework

In this example the APT design methodology provided a robust and evidence based process through which to compare and contrast the affordances of four prominent VLEs, in relation to the presences of the Community of Inquiry framework.

Example 2: Programme Assessment Evaluation

A second example is currently only in early stages of development, but uses the same design methodology as outlined above. In this example, the challenge is to find a way in which to visualise programme based assessment, in order to highlight strengths and weaknesses across the various modules that might make up that programme, and look for ways to address potential shortcomings, again bringing in digital technologies to support any proposed change.

The first step, as before, is to explore literature in order to find principles that capture good practice in assessment and feedback. Two potential candidates have so far been identified, both with common ancestry within the wider assessment literature (e.g. Nicol and Macfarlane-Dick, 2006; Gibbs and Simpson, 2004; Chickering and Gamson, 1991) which have now been reformed as dimensions models ready for the alignment of digital technologies:

- The Viewpoints project at Ulster (http://jiscdesignstudio.pbworks.com/Viewpoints-project)
- The ESCAPE project at Hertfordshire (http://jiscdesignstudio.pbworks.com/ESCAPE-Project)

Dimension models have again been created using principles from these projects, and are depicted below in Figures 9.3 and 9.4, below:

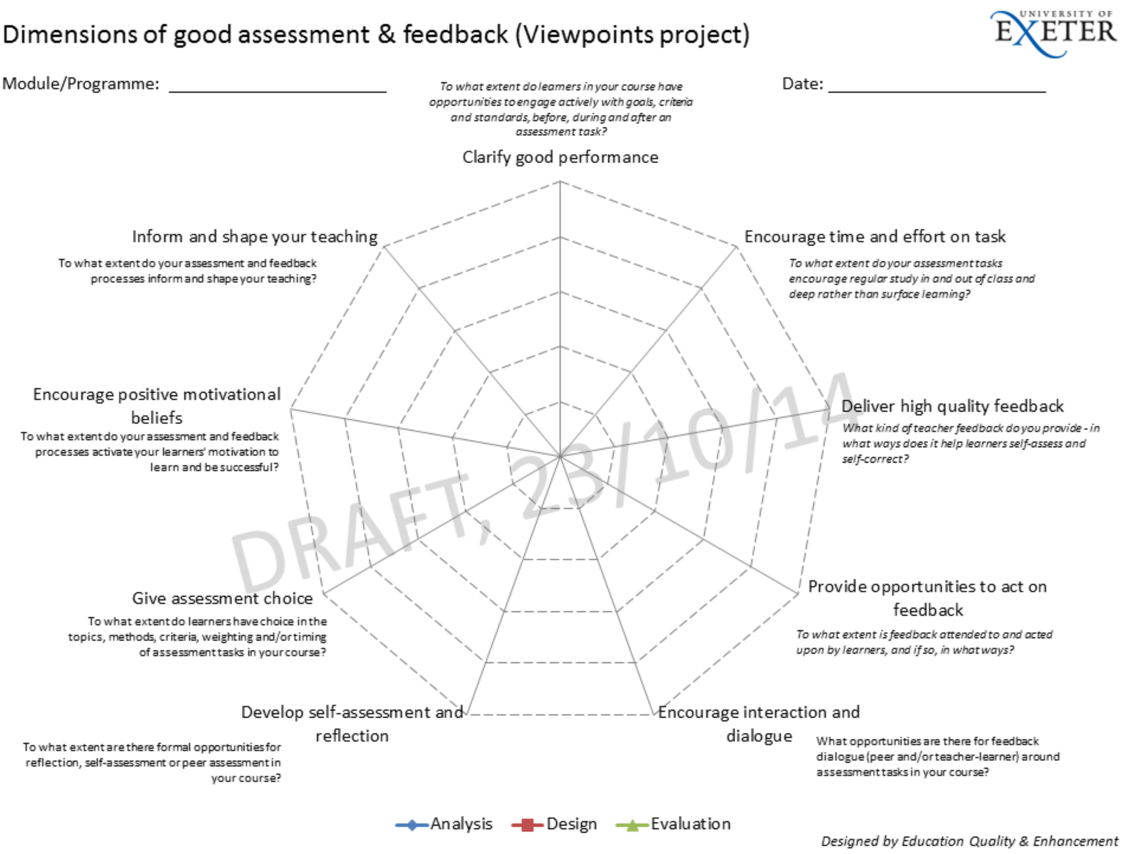


Figure 9.3: Dimensions model using the Viewpoints principles

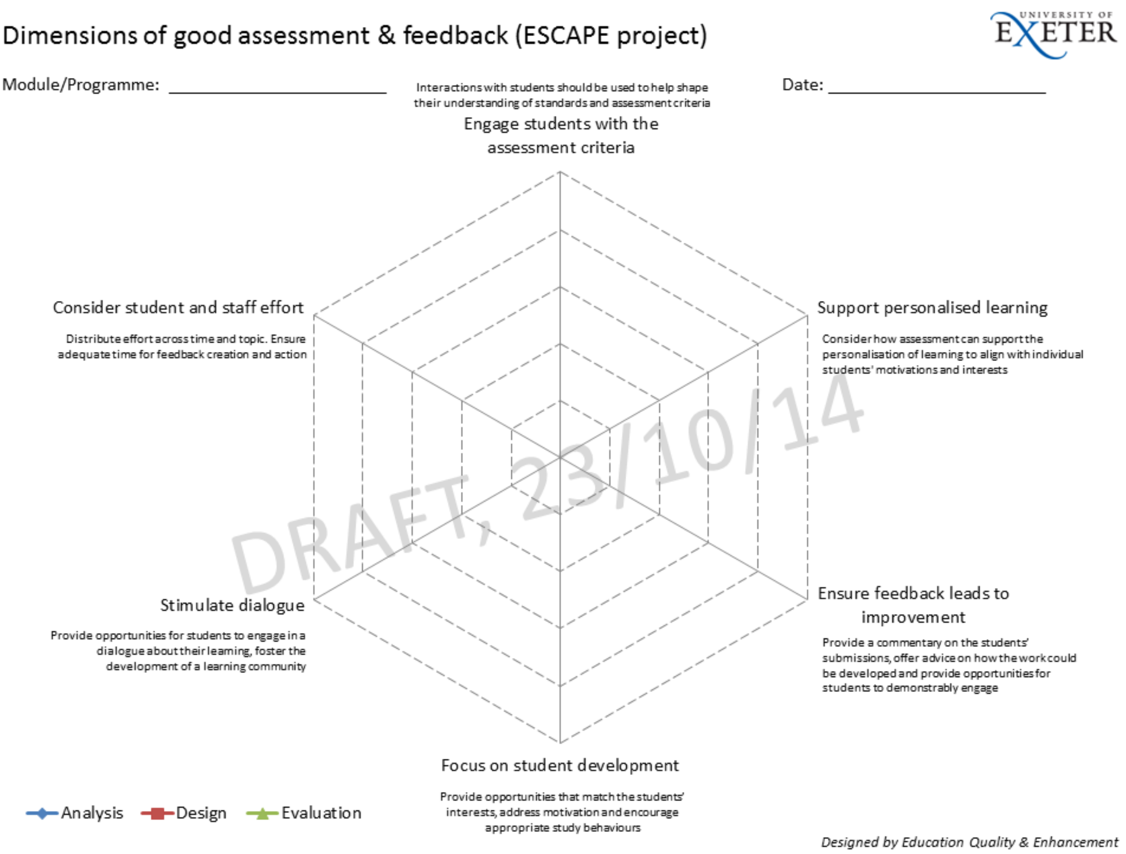


Figure 9.4: Dimension model using the ESCAPE principles

The Tech Trumps are now being re-evaluated against these models in order to identify their potential affordances given this new pedagogic intention, and hence create a new ‘pack’ of digital playing cards which match this intention, using the dialogic approach as described earlier to ascertain what the digital technologies might provide or furnish given this new context. Although only in its very early stages of development, these models have already shown promise in the alignment of specific technologies with this broader pedagogic challenge, for example providing a better understanding of how components of the University’s Virtual Learning Environment might be more effectively aligned with practice in order to improve the experience of learners.

The design methodology shows promise as a way in which any pedagogic intention might be captured, and hence provide the context within which to align digital technologies which have the potential to support that intention. However, more research is needed in order to qualify its potential usefulness to the wider educational technology community.

Appendices

Note: In order to aid the reader appendices have been prefixed with ‘A’ to indicate work at School A, and ‘E’ to indicate work at the University of Exeter.

Appendix A1: Parental Consent Letter and Form

School of Education
University of Exeter
Heavitree Road
Exeter
EX1 2LU

Dear Parent,

Re: Research Project "Using Adobe Visual Communicator to teach Modern Foreign Languages at Key Stage 3/4 in a UK Secondary School"

I am a member of staff and a PhD student with the University of Exeter, and my focus of research is on the use of technology (more specifically ICT or Information & Communication Technology) within education. I am exploring how specific properties of technology may be used to enhance education.

[redacted] has agreed to participate with my research, and during the past term I have been equipping them with specific software and hardware that allows the Modern Foreign Languages department to explore news ways of combining text, video and audio during French lessons. During this pilot stage we have been trying to ensure that everything is working correctly, and now we are looking forward to the next academic year when the main body of the research will take place. Your child is a member of a class that has been selected to participate in the research over the next academic year.

During the research various methods will be used to gather data, including questionnaires, short interviews and video. Whilst the paper based data gathering is relatively straightforward, it was decided to also use video within the project in order to gather as much rich data as possible about the way a learning child is interacting with a complex technological space. The focus of the video will be the interaction between the child and the technology, not the child themselves, and indeed the prime data is the audio stream between the children as they work with the technology (they will be working in groups) rather than the video stream. The video stream will be used to understand how the child's comments relate to their actions, as they commonly point to various objects on screen as they are working with the technology, and their expressions and motions can be powerful cues as to their underlying learning processes.

I can assure you that any video data that is gathered will be done solely within the classroom during normal lesson time, it will be stored in a secure way on protected computer equipment, and will only used for analysis of learner interactions over time. At no point will video data be disclosed to any third party without further explicit permission from yourself, and no video will be published in any way without further consent.

If you are happy for your child to participate in this project I would ask that you please sign and return the attached consent form. If you have any questions or concerns about the research please feel free to contact me directly, either by email (r.m.osborne@exeter.ac.uk) or by phone (01392 26 4951), or alternatively you may contact the School Research office again either by email (ed-research@exeter.ac.uk) or by phone (01392 26 4758).

Yours faithfully,

Richard Osborne

SCHOOL OF EDUCATION AND LIFELONG LEARNING

CONSENT FORM

Research Project: "Using Adobe Visual Communicator to teach Modern Foreign Languages at Key Stage 3/4 in a UK Secondary School"

I have been fully informed about the aims and purposes of the project.

I understand that:

- there is no compulsion for my child to participate in this research project and, if they do choose to participate, they may at any stage withdraw their participation
- I have the right to refuse permission for the publication of any information about my child
- Any information given will be used solely for the purposes of this research project, which may include publications
- If applicable, the information which is given may be shared between other researcher(s) participating in this project in an anonymised form
- All information given will be treated as confidential
- The researcher(s) will make every effort to preserve anonymity

....

(Signature of parent

……………………

(Printed name of parent)

....

(Date)

Data Protection Act: The University of Exeter is a data collector and is registered with the Office of the Data Protection Commissioner as required to do under the Data Protection Act 1998. The information you provide will be used for research purposes and will be processed in accordance with the University's registration and current data protection legislation. Data will be confidential to the researcher(s) and will not be disclosed to any unauthorised third parties without further agreement by the participant. Reports based on the data will be in anonymised form.

Appendix A2: Summary of Teacher Data

Data Gathering Handout - Teachers

Timestamp	Class	Teacher	Date	Technical issues with the ICT have caused ...	The students have learned ...	The use of ICT has ...
20/10/2009 06:06:53	10C/FR1 (Wednesday, Lesson 1)	Teacher C	16/09/2009. 9:00	4	4	4
20/10/2009 06:08:24	10C/FR1 (Wednesday, Lesson 1)	Teacher A	30/09/2009, 9:00	5	4	3
20/10/2009 06:10:42	9X/FR1 (Wednesday, Lesson 5)	Teacher B	16/09/2009, 14:15	5	5	7
20/10/2009 06:12:01	9X/FR1 (Wednesday, Lesson 5)	Teacher B	30/09/2009, 14:15	4	4	5
20/10/2009 06:14:01	10C/FR1 (Wednesday, Lesson 1)	Teacher D	14/10/2009, 9:00	4	4	5
20/10/2009 06:14:29	9X/FR1 (Wednesday, Lesson 5)	Teacher B	14/10/2009, 14:15	4	6	6
10/11/2009 18:35:11	9X/FR1 (Wednesday, Lesson 5)	Teacher B	04/11/2009, 14:15	5	5	6
10/11/2009 18:35:43	10C/FR1 (Wednesday, Lesson 1)	Teacher A	04/11/2009, 9:00	2	4	5
25/11/2009 18:59:01	10C/FR1 (Wednesday, Lesson 1)	Teacher A	18/11/2009, 9:00	2	4	5
25/11/2009 19:00:38	9X/FR1 (Wednesday, Lesson 5)	Teacher B	18/11/2009, 14:15	2	6	6
03/12/2009 15:27:17	9X/FR1 (Wednesday, Lesson 5)	Teacher B	02/12/2009, 14:15	4	5	4
14/12/2009 21:06:54	10C/FR1 (Wednesday, Lesson 1)	Teacher A	02/12/2009, 9:00	3	4	4
03/01/2010 16:39:20	9X/FR1 (Wednesday, Lesson 5)	Teacher B	16/12/2009, 14:15	3	6	6
03/01/2010 16:39:36	10C/FR1 (Wednesday, Lesson 1)	Teacher A	16/12/2009, 9:00	7	4	3

1

Appendix A3: Summary of Student Data

Student Star Ratings

Class	Date	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	No. Cards	No. Students	Average Score
10C/FR1	16/09/2009 09:00:00	2	0	3	0	4	0	7	0	4	0	0	20	20	2.40
9X/FR1	16/09/2009 14:15:00	0	0	2	1	7	2	10	1	4	0	0	27	27	2.67
10C/FR1	30/09/2009 09:00:00	3	1	2	0	4	1	2	0	5	0	1	19	19	2.32
9X/FR1	30/09/2009 14:15:00	0	0	0	0	4	1	14	0	6	0	3	28	29	3.27
10C/FR1	14/10/2009 09:00:00	2	0	0	0	1	0	4	1	3	0	0	11	10	2.68
9X/FR1	14/10/2009 14:15:00	0	1	0	0	2	5	12	3	7	1	1	32	32	3.16
10C/FR1	04/11/2009 09:00:00	6	0	1	0	1	0	9	1	3	0	0	21	22	2.17
9X/FR1	04/11/2009 14:15:00	0	1	3	0	6	2	9	0	1	1	1	24	24	2.54
10C/FR1	18/11/2009 09:00:00	2	0	1	0	3	0	6	0	3	0	0	15	20	2.47
9X/FR1	18/11/2009 14:15:00	0	0	1	0	4	3	11	2	5	0	2	28	28	3.09
10C/FR1	02/12/2009 09:00:00	0	2	2	0	4	0	4	0	4	0	0	16	19	2.44
9X/FR1	02/12/2009 14:15:00	1	3	6	2	5	1	7	1	4	0	0	30	30	2.12
10C/FR1	16/12/2009 09:00:00	3	0	3	0	5	0	2	0	2	0	2	17	18	2.18
9X/FR1	16/12/2009 14:15:00	2	2	5	0	6	1	8	0	1	0	4	29	31	2.36

1

Appendix A4: Research Notes (blank)

Research Notes (blank)

Class (inc. time & date):

Teacher:

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils:

Total 'Star' Score:

Objective of lesson:

Equipment being used:

General Notes on Session:

Research Notes Page 1

Appendix A5: Research Notes

Research Notes for Visual Communicator Project

Class (inc. time & date): 10C / Fr 1 (9:00, 18/9/09)

Teacher: [redacted]
& [redacted] (support & TA) [redacted] not here)

Technical Issue Score: 4
Students Learning Score: 4
Use of ICT Score: 4

Number of pupils: 20

Total 'Star' Score: 48

Objective of lesson:

Equipment being used: 10 laptops & webcams

General Notes on Session:

Laptops very slow to start up.

Webcam set-up needs to be shown.

Video camera pointing at laptop better?

Log off / Log on problems?
(no software showing on launch)
apparently school wide issue?
Very gender split - girls work together and boys work together

Research Notes Page 1

Research Notes for Visual Communicator Project

Class (inc. time & date): 9X / Fr 1 (14:15, 16/9/09)

Teacher: [redacted]

Technical Issue Score: ~~5~~ 3 (adjusted after change of scales)

Students Learning Score: 5

Use of ICT Score: 7

Number of pupils: 27

Total 'Star' Score: 73

Objective of lesson: Use ICT to improve speaking skills

Equipment being used: 9 Laptops & webcams

General Notes on Session:

Not challenging enough! Because we prepared better for this lesson by getting students to write content ahead of time, they'd finished too early.

"Min spec" warning on Dell Latitude SoS; 600 detected, 800 needed

⇒ Some sort of battery saving setting on?

Motivation seems up, but not here to study motivation, so think it's OK ~~not~~ to measure.

Stars not giving enough variability in answer → increase number to 7 perhaps?

Re-work first ICT question for teachers?

Maybe do set of personal reflection for the researcher as well?

Research Notes Page 3

Research Notes for Visual Communicator Project

Class (inc. time & date): 10C / Fr 1 (9:00, 30/9/09)

Teacher: [redacted]
+ [redacted] (assistant)
+ PGCE student

Technical Issue Score: 5

Students Learning Score: 4

Use of ICT Score: 3

Number of pupils: 19

Total 'Star' Score: 45
(3 zero, laptop failure)

Objective of lesson:

Equipment being used: Laptops & webcams

General Notes on Session:

Students working in pairs to practice interview technique asking questions and responding.

Half lesson (+) used to talk about plans for forthcoming lessons, so not much time for tech.

LTS-09 difficult + 08 + 15

Check for patch for VC3?

Research Notes Page 4

Research Notes for Visual Communicator Project

Class (inc. time & date): 9X Fr 1 (13:15, 30/9/09)

Teacher: [redacted]
+ [redacted] (French assistant)
+ PGCE Student

Technical Issue Score: 4
Students Learning Score: 4
Use of ICT Score: 5

Number of pupils: 29 (28 cards)

Total 'Star' Score: 91½

Objective of lesson: Contribute to pres. on describing your school

Equipment being used: Laptops & webcams

General Notes on Session:

Preparation on paper or word, means I can't study anything – need to be using the virtual space.

LTS - 07 freezing

Research Notes Page 5

Research Notes for Visual Communicator Project

Class (inc. time & date): 10C/Kr1 (9:00, 14/10/09)

Teacher: [redacted]
(Standing in for [redacted])

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 10

Total 'Star' Score:

Objective of lesson: Continue drafting & recording speech (practice for Oral exam)

Equipment being used: Laptops & webcams

General Notes on Session:

CTS-05; showing "processor too slow" message

Logging on/off to get program listed - must investigate.

CTS-14 - can't get programs to come up

Very few pupils and lack of regular teacher make pupils unwilling to learn

Research Notes Page 6

Research Notes for Visual Communicator Project

Class (inc. time & date): 9X / Kr 1 (14:15, 14/10/09)

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 32

Total 'Star' Score:

Objective of lesson: Talk about School rules

Equipment being used: Laptops & Webcams

General Notes on Session:

Research Notes Page 7

Research Notes for Visual Communicator Project

Class (inc. time & date): 10C/Kr1 (9:00, 4/11/09)

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 22

Total 'Star' Score:

Objective of lesson: Work on improving speaking skills in pairs

Equipment being used: Laptops & webcams

General Notes on Session:

At beginning one student asking why they can't just speak – why the technology

[redacted] tries to explain it's to do with the "cyclic" nature (in my words?)

LTS-09 claims to be too low powered

Atmosphere rapidly becomes calmer, students getting on with what they're doing.

Question: Are the motivational qualities

Research Notes Page 8

Assimilating ?: seem much less enamoured with the technology.

CTS-14 Crashing with error message (VC only)

CTS-15 Not playing sound.

Research Notes Page 9

Research Notes for Visual Communicator Project

Class (inc. time & date): 9x / Fr 1 (14:15, 4/11/09)

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 24

Total 'Star' Score:

Objective of lesson: Use speaking skills to revise future tense

Equipment being used: Laptops & Webcams

General Notes on Session:

LTS-14 Crashing with error (VC3)

Lots of chatting, lack of focus on task

Ales thinking: Is it as simple as the actual thing? So easy to change what is held in the virtual space, even easier than a rubber?

Next lesson introduce images

CTS-12 was odd, but might just be low battery

Research Notes for Visual Communicator Project

Class (inc. time & date): 10Kr1, 9:09, 18th Nov '09

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 20

Total 'Star' Score:

Objective of lesson: Continuing on Interviews

Equipment being used: Laptops & Webcams

General Notes on Session:

[redacted] VC3 Licence :
[redacted]

LTS-12 Complaining too low
(600MHz rather than 800MHz)

LTS-15 trying to publish, hung

Overheard comment – "I feel sad if
I don't give him 1" (on Star Card)

Research Notes Page 11

Research Notes for Visual Communicator Project

Class (inc. time & date): 9X Kr 1, 2:15 on 18/11/09

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 28

Total 'Star' Score:

Objective of lesson: Home - building self assessment - creating more confident speakers project

Equipment being used:

General Notes on Session:

LTS-12 reporting too low powered (600 not 800)

Students seem highly motivated today, almost all working well

LTS-02 being a problem

Research Notes Page 12

Research Notes for Visual Communicator Project

Class (inc. time & date): 10Kr1 , 9:00 2/12/09

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 19

Total 'Star' Score:

Objective of lesson: Complete dialogue and publish

Equipment being used: Webcams 2 Laptops

General Notes on Session:

LTS-05 complaining too low
(600 MHz not 800MHz)

Research Notes for Visual Communicator Project

Class (inc. time & date): 9X Fr1 , 14:15 , 2/12/09

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 30

Total 'Star' Score:

Objective of lesson: Complete description of your family for speaking practice

Equipment being used:

General Notes on Session:

Motivation issues of being watched ?

Always the same question, "Sir, is that filming us ?"

Room has wired network sockets – can these be used ?

PCs setting very difficult – network issues ?

CIS - 13 casing problems

Research Notes Page 14

Research Notes for Visual Communicator Project

Class (inc. time & date): 10 Gr 1 16/12/09, 9:00 am.

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 18

Total 'Star' Score:

Objective of lesson: Finishing speaking practice.

Equipment being used: Laptops & webcams

General Notes on Session:

Focus on product not process

CTS-07 terminating with error

CTS-11

Running out of disk space?

3 drives?

All machines failing badly!

Research Notes Page 15

Research Notes for Visual Communicator Project

Class (inc. time & date): 9x Fr1 16/12/09, 14:15

Teacher: [redacted]

Technical Issue Score:

Students Learning Score:

Use of ICT Score:

Number of pupils: 31

Total 'Star' Score:

Objective of lesson: Complete written presentation of your finishing

Equipment being used: Laptops & webcams

General Notes on Session:

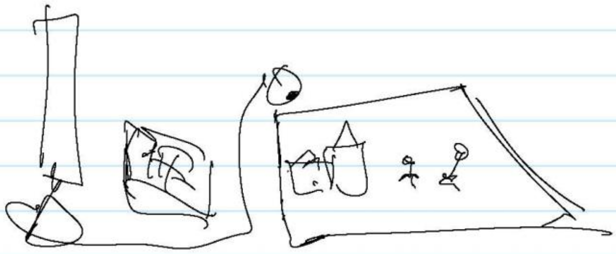
Laptops seem much better this afternoon

CTS-11 charging

CTS-15 charging (very bad, had to swap it)

Two girls drawn with pencil to illustrate story, and point the camera at the pictures as they go

Research Notes Page 16



Research Notes Page 17

Appendix A6: Ethical Approval Form

STUDENT HIGHER-LEVEL RESEARCH

UNIVERSITY OF EXETER

School of Education and Lifelong Learning

Certificate of ethical research approval

STUDENT RESEARCH/FIELDWORK/CASEWORK AND DISSERTATION/THESIS
You will need to complete this certificate when you undertake a piece of higher-level research (e.g. Masters, PhD, EdD level).

To activate this certificate you need to first sign it yourself, then have it signed by your supervisor and by the Chair of the School's Ethics Committee.

For further information on ethical educational research access the guidelines on the BERA web site: http://www.bera.ac.uk/publications/guides.php and view the School's statement in your handbooks.

READ THIS FORM CAREFULLY AND THEN COMPLETE IT ON YOUR COMPUTER (the form will expand to contain the text you enter).
DO NOT COMPLETE BY HAND

Your name: Richard Osborne

Your student no: 560029293

Degree/Programme of Study: PHD Education (PRP3EDUEDU01)

Project Supervisor(s): Professor Patrick Dillon & Dr Penni Tearle

Your email address: ro216@exeter.ac.uk

Tel: 07970075346

Title of your project: Using Adobe Visual Communicator to teach Modern Foreign Languages at Key Stage 3/4 in a UK Secondary School

Brief description of your research project
The project is a longitudinal case study spread over 2 academic years of two classes of MFL students who are utilising the Adobe software package Visual Communicator 3 as part of their Modern Language programme of study. The research study sets out to study the nature of virtual spaces and associated learning processes.
The aim of the study is two fold:

- To identity the unique qualities of virtual spaces within a learning process

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last updated: September 2007

- To develop teaching & learning scenarios that utilise any of the unique qualities identified in order to enhance learning

Within the single case study, three methods will be used:

- Videos of the students working with the software during their MFL classes
- Semi-structured interviews with the 2 teachers involved in the study
- Semi-structured interviews with at least 14 of the 67 students involved in the study

Give details of the participants in this research (giving ages of any children and/or young people involved):
Two classes from the [redacted] will be involved in the study:

- Class 1 is a year 9 class, led by [redacted] consisting of 33 students of mixed gender aged between 13 and 14.
- Class 2 is a year 8 class, led by [redacted] consisting of 34 students of mixed gender aged between 12 and 13.

I should declare that [redacted] is my partner. As the study is primarily interested in the data from the children I do not see this as a problem and am confident I can maintain an impartial and professional relationship.

Give details regarding the ethical issues of informed consent, anonymity and confidentiality (with special reference to any children or those with special needs) a blank consent form can be downloaded from the SELL student access on-line documents:
Both teachers in the study have been involved in the plans from the outset, and are fully aware of both the nature of the study and the methods of data collection. Other teachers within the MFL department are also aware of this research study as is the ICT co-ordinator at [redacted] and the Head of School, who has given her permission and support to the research
Parents have already given consent for their children to be involved in the research and also filmed as part of the School's own requirements, nevertheless individual consent will also be sought from parents specifically as part of the study. Any students for whom consent is not given will not be filmed or interviewed for the study. As each class has more than 30 pupils and only a sample of these will be used in the study this is unlikely to be a problem.
Pupils have all been informed of the plans, and I have held introductory sessions with them to talk about the proposed project and hear their thoughts.
It will obviously not be possible to film anonymously, but any coding taken from the videos as well as data from the interviews will be analysed anonymously.

Give details of the methods to be used for data collection and analysis and how you would ensure they do not cause any harm, detriment or unreasonable stress:
The primary tool for gathering data will be video. In order to ensure that this method of data collection is as unobtrusive as possible, both in terms of data purity and in terms of causing stress to the participants, a very small yet high quality video camera has been chosen (the Flip Ultra HD) that can be attached unobtrusively using a 'Gorillapod' tripod to specific situations where data is required. This will also enable small groups to be closely filmed without involving others. It is anticipated that the camera will be left in place unattended for fairly long periods of the hour teaching sessions which will be filmed. It is planned to film just two or three specific episodes of interactions between pupils and the ICT, therefore minimising any stress or bias.

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last updated: September 2007

Interviews with teachers will be carried out on a one-to-one basis. Pupils will be interviewed in pairs (or threes) in order to minimise any stress that this technique can generate.

Give details of any other ethical issues which may arise from this project (e.g. secure storage of videos/recorded interviews/photos/completed questionnaires or special arrangements made for participants with special needs etc.):
All original video & interview data will be kept on a computer that has been secured using a strong username/password combination, and is used only by myself. Back-ups of the originals will be automatically made and stored online using a professional back-up environment (Carbonite). Copies of the data for analysis will also be stored on a username/password protected computer
The video data will only be used for coding purposes. It is not intended to make any video more widely available as part of dissemination activities, or within the thesis. If it is later felt important to make any of the video more widely available, specific approval will be sought from the relevant parties.

Give details of any exceptional factors, which may raise ethical issues (e.g. potential political or ideological conflicts which may pose danger or harm to participants):
As I will be working in a school with students I have sought and been given a Criminal Record Bureau check, so have been cleared to work with children.
I should declare that I have a professional relationship with Adobe, as I am an Adobe Education Leader, one of a number of education professionals from around the world who "have used their unique abilities and expertise to promote excellence in education through the integration of Adobe solutions in the classroom, school, or district". This is solely an honorary position though, and although the software for the study has been provided by the company free of charge neither myself nor the company stand to gain financially from the arrangement. If the research proves interesting Adobe may wish to create their own case study, but any ethical issues created by this would be dealt with completely separately from the research project.

***This form should now be printed out**, signed by you below and sent to your supervisor to sign. Your supervisor will forward this document to the School's **Research Support Office** for the Chair of the School's Ethics Committee to countersign. A unique approval reference will be added and this certificate will be returned to you to be included at the back of your dissertation/thesis.*

I hereby certify that I will abide by the details given above and that I undertake in my dissertation / thesis (delete whichever is inappropriate) **to respect the dignity and privacy of those participating in this research.**

I confirm that if my research should change radically, I will complete a further form.

Signed:...... ....date:......15/6/09.....

***N.B**. You should not start the fieldwork part of the project until you have the signature of your supervisor*

Chair of the School's Ethics Committee
last updated: September 2007

This project has been approved for the period: July '09 **until:** July '10

By (above mentioned supervisor's signature): ......Pennie Teale...... **date:** 16.06.09

N.B. To Supervisor: *Please ensure that ethical issues are addressed annually in your report and if any changes in the research occurs a further form is completed.*

SELL unique approval reference:......D/08/09/63......

Signed:......[signature]...... **date:** 01/07/09

Chair of the School's Ethics Committee

This form is available from
http://www.education.ex.ac.uk/students/index.php then click on On-line documents.

Chair of the School's Ethics Committee
last updated: September 2007

Appendix E1: Consent Form (Context Interviews)

Consent Form

COLLABORATE JISC UNIVERSITY OF EXETER

(Image, Voice & Video)

About the Exeter Collaborate project

Collaborate is an ambitious 2 year JISC funded project, run by the Education Enhancement division at the University of Exeter, which aims to introduce new generation assignments based around real-world and scenario based activities designed collaboratively by programme teams, students and employers

Why we are asking you to sign this form

The information we collect from you may be in the form of an audio or video recording (which may be transcribed later i.e. your words recorded as text), or we may ask to take your photograph, perhaps while engaged in a research or study activity, alone or with others. We may also take notes during our conversation.

We require your permission to record this information and save it to a computer. **Part (a)** gives your permission to do this and to use the information we collect for the purposes of ***research***. This means that we will only share the information among ourselves (the research team).
We will not make it public at any time, nor will we quote your words in any way that could identify you. We will write reports for the University of Exeter and the funding body in which your views may be summarised and your words may be quoted anonymously. These reports may be made public. The original data will be securely deleted at the end of the project.

If we ask you to sign it, **part (b)** gives your permission for us also to use images, voice recordings, or video of yourself ***publicly*** to help raise awareness of the work of the project. This may be done via conference presentations, a University of Exeter web site, print communications about the project, or other forms of online and offline communication. Your image, voice or video will only appear in the context of scholarly communications about the Exeter Collaborate project.
You ***do not*** have to sign part (b) to participate in this research.

Part (a)

I confirm that I have read and understood the information about the Exeter Collaborate project and have had the opportunity to ask questions. **I agree** to my voice being recorded and to a transcription or notes being made. **I agree** that the transcription or notes may be used for research and report writing by the Exeter Collaborate project, including anonymous quotation.

Part (b) *(Delete if not applicable)*

I hereby grant the Exeter Collaborate project the right to the photograph(s) | audio recording(s) | video recording(s) (delete as applicable) taken of me on …..(date) for all general purposes in relation to the project's work including, without limitation, the right to use them in any communication materials online or in print.

Name: …………….……………………………………………………………………… *(Please print)*

Signature: ……………………………………………………………….. Date: ……………………….

Appendix E2: Module Descriptor Template

UNIVERSITY OF EXETER

MODULE TITLE					**CREDIT VALUE**	
MODULE CODE			**MODULE CONVENER**			
DURATION	**TERM**	**1**	**2**	**3**	**Number Students Taking Module (anticipated)**	
	WEEKS					

DESCRIPTION – summary of the module content (100 words)

To be **written to the student** describing the distinctive features of the Module and any unique activities or opportunities. Why a student should take this module

What prior knowledge skills or experience ***including pre-requisite and co-requisite modules*** *does a student need to have in order to be able to take this module?*
Is this module suitable/ unsuitable for specialist/ non-specialist students?
Is this module recommended for interdisciplinary pathways?

MODULE AIMS – intentions of the module

What do lecturers hope to cover in this module in terms of knowledge and learning opportunities for the students? Include details of research-enriched learning/ teaching and links to employment.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)
On successful completion of this module ***you should be able to***:

Module Specific Skills and Knowledge:	
1	The ILOs are not limited to 6 – numbers are provided here as a reminder to list ILOs alpha-numerically
2	
Discipline Specific Skills and Knowledge:	
3	
4	
Personal and Key Transferable/ Employment Skills and Knowledge:	
5	
6	

SYLLABUS PLAN – summary of the structure and academic content of the module

The syllabus plan **should not be provided on a week-by-week basis** unless the delivery pattern can be guaranteed

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching activities		Guided independent study		Placement/study abroad		See notes for guidance

1

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS		
Category	Hours of study time	Description

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade			
Form of Assessment	Size of the assessment e.g. duration/length	ILOs assessed	Feedback method

SUMMATIVE ASSESSMENT (% of credit)					
Coursework		Written exams		Practical exams	

DETAILS OF SUMMATIVE ASSESSMENT				
Form of Assessment	% of credit	Size of the assessment e.g. duration/length	ILOs assessed	Feedback method

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)			
Original form of assessment	Form of re-assessment	ILOs re-assessed	Time scale for re-assessment

RE-ASSESSMENT NOTES – give details of how re-assessment will be calculated. This section can also be used to indicate where re-assessment is not available

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener.

Basic reading:

ELE – *College to provide hyperlink to appropriate pages*

Web based and electronic resources:

Other resources:

CREDIT VALUE		**ECTS VALUE**	
PRE-REQUISITE MODULES			
CO-REQUISITE MODULES			
NQF LEVEL (FHEQ)		**AVAILABLE AS DISTANCE LEARNING**	YES / NO
ORIGIN DATE		**LAST REVISION DATE**	
KEY WORDS SEARCH			

Module Descriptor Template Revised October 2011

2

Appendix E3: Interview Questions (Context)

Interview Overview and Questions

Purpose of Interviews

The purpose of the baseline interviews is to gather a snapshot impression of assessment practices at the University of Exeter, as well as to gather wider opinions from key stakeholders as to the nature of assessment, specifically in relationship to technology and to employability.

The interviews are "semi-structured", with a specific set of questions for specific stakeholders, followed by a generic set of questions. These are not designed to be 'hard and fast' though, and are adapted according to each interview as appropriate, depending upon the candidate's responses and the way the interview in progressing. Nevertheless an attempt will be made to ask all questions if possible, even if slightly adapted and in a different sequence, in order to enable comparative analysis between stakeholder groups and individual interviewees at a later date.

All videos are filmed, at the discretion of the interviewee.

Overall Interview Structure

Each individual interview follows this basic structure:

Welcome and thank you for attending

- Introduction from interviewer(s)
- Name of interviewee, position held, involvement with project, course etc (if appropriate)
- Permission to share filming publicly form
- Introduction to the project - What is 'Collaborate'?

What is 'Collaborate'?

Collaborate is a 2 year JISC funded project, being run by the Education Enhancement division at the University of Exeter, which aims to introduce new generation assignments based around real-world and scenario based activities designed collaboratively by staff, students and employers.

These interviews are being carried out as part of an initial period of baselining, in order to gather a snapshot impression of assessment practices at the University of Exeter, as well as to gather wider opinions from key stakeholders such as yourself as to the issues surrounding assessment, particularly with regards to technology and employability.

- Then ask specific stakeholder group questions (choose one from the following three sections)

Specific Questions: Staff

1. Do you think a *gap* exists between current assessment practice and the needs of employers?
2. Are you currently involved in work that aims to *improve* employability using assessment, either formally or informally?
3. How are you currently involved in the use of *technology* within assessments?

Specific Questions: Student

1. What was the 'best' assessment you've ever had at Exeter?
2. What would you change about the assessments you're currently undertaking if you had the chance?
3. How well balanced is the use of technology in your assessments at present?
4. How do you think the assessments you are currently undertaking help you prepare for your future employment?

Specific Questions: Employers

1. Thinking back to your own education, do any assessments stand out in your mind as particularly memorable?
2. Thinking about new graduates who join your company, what investments in skills training do you typically have to make for them?
3. How valuable are graduate employees who can use new or existing

technologies in innovative ways?
4. What type of assessment or other evaluative processes do you make use of in your business?

- Followed by generic questions

Generic Questions

1. How familiar are you with the various *forms* of assessment, such as summative, formative, criterion referenced, diagnostic, synoptic and authentic?
2. What *changes* do you think could be made to assessments in order to make them more 'authentic', i.e. employment focused?
3. Are they any technologies that you find particularly useful in your work?
4. How could the Collaborate project help you in what you're trying to achieve personally?

End of interview and thank you

- Any questions they would like to ask?
- Thanks for time, opportunity to stay involved (would they like to be added to email list)

Appendix E4: Work-integrated Assessment: Change Continuum Tool

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COLLABORATE draft UNIVERSITY OF EXETER

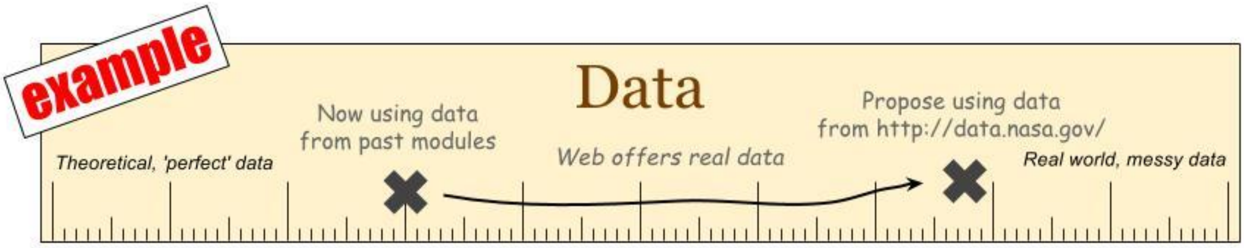
"Bringing together staff, students and employers to create employability focused assessments enhanced by technology"

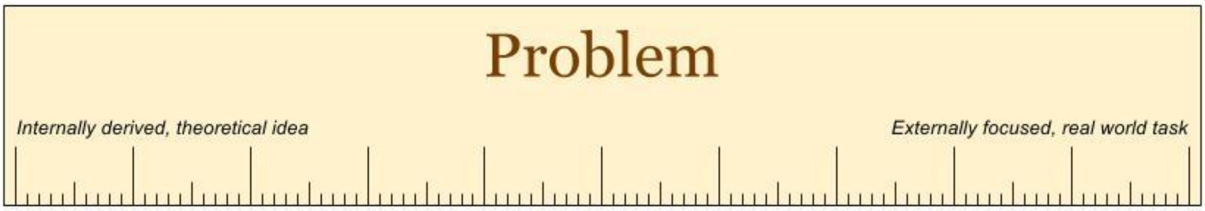
Work-integrated Assessment: Change Continuum Tool

The concept of a work-integrated assessment is an assessment where the tasks involved more closely resemble those which you would be carrying out in employment. This change continuum tool is designed to scaffold thinking by asking the questions:

- At what position does your current assessment fall on these continuum's?
- Where would you like your assessment to be placed on these continuum's?
- How could your current assessment be changed to move in this direction?
- How could the introduction of technology help shift this position?

Assessment: ____





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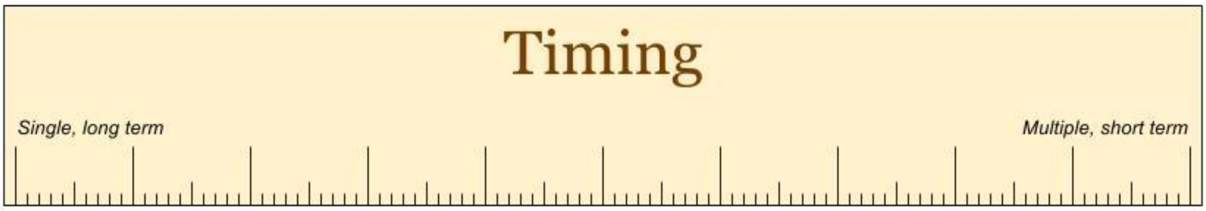
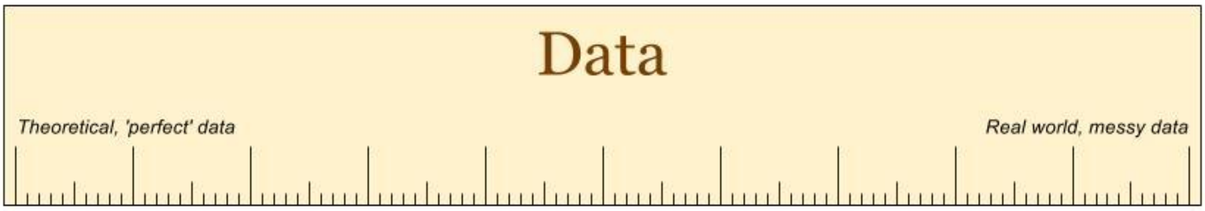


Assessements are often delivered in the form of examinations at the end of learning. In employment however timing is often out of your individual control, and you usually have to juggle multiple tasks at the same time.



The individual pieces of data that you need to work with in employment rarely come in coherent, standard forms. They are usually in 'messier' formats that need to be interpreteted to be of use.

Review

Tutor review — *Peer review*

The 'sage on the stage' mentality puts the academic firmly in charge of the review process. Extending the review process to students encourages a deeper understanding of the learning that has taken place, by requiring reflection over the way a task has been undertaken.

Structure

Formal structure and requirements — *Open challenge*

Current thinking on assessment practice advises that assessments should be well structured, with clear guidance to students. However in employment part of the challenge of a task is to create the process(es) necessary to achieve it.

Social

Working alone — *Working in collaboration*

Many forms of assessment require the assessee to work alone, yet in employment tasks invariably require some form of collaboration. Encouraging students to work with peers helps build their collaborative skills.

Audience

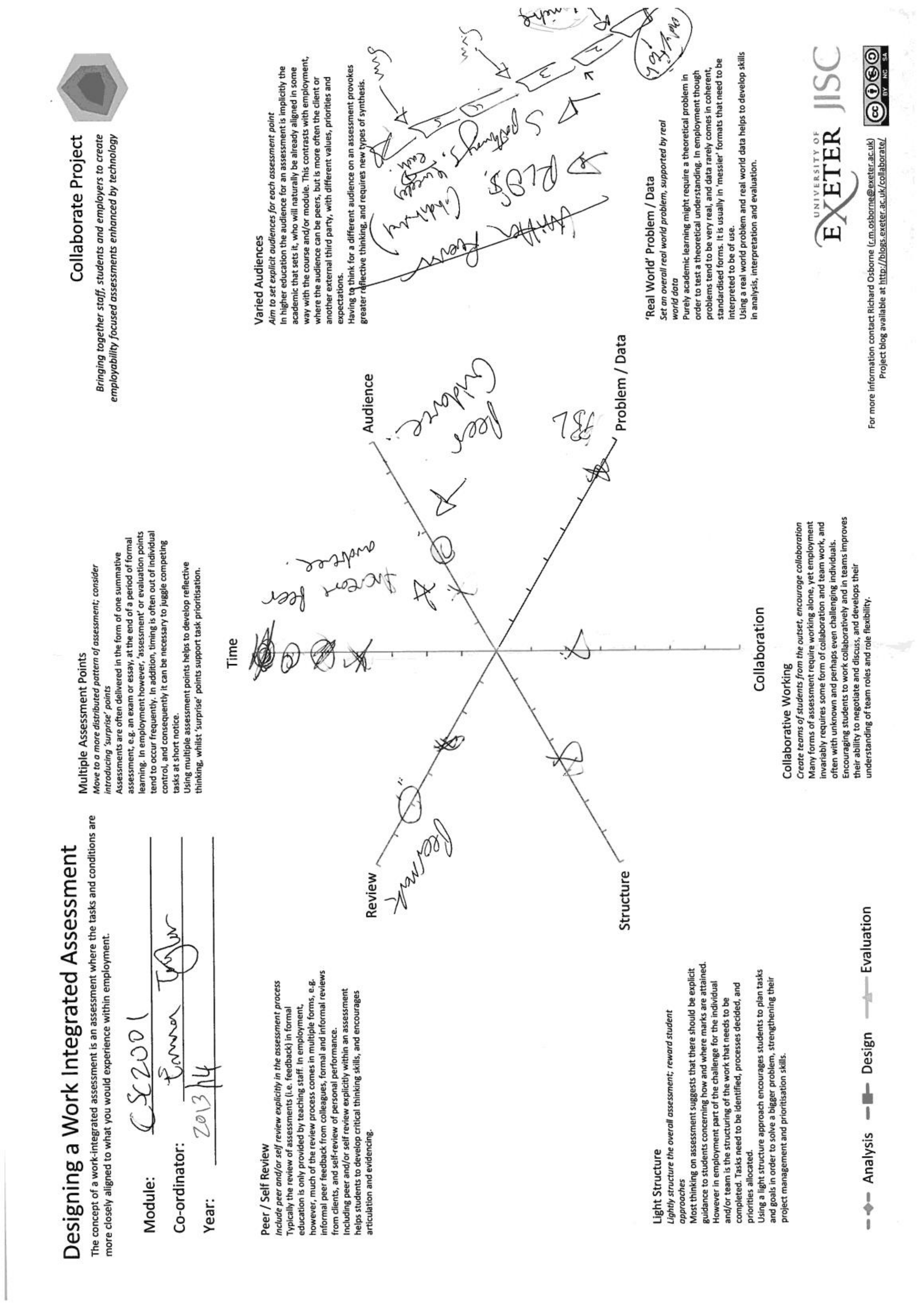
Academic, internally directed — *Business, externally directed*

The audience for an assessment is typically the academic that sets it. This contrasts with employment, where the audience for work done is a client. Focusing on different audiences provokes reflection over content, and new levels of synthesis.

Feedback?

http://blogs.exeter.ac.uk/collaborate/

Appendix E5: Completed dimension models



Dimensions of a Work Integrated Assessment

The concept of a work-integrated assessment is an assessment where the tasks and conditions are more closely aligned to what you would experience within employment.

This example shows a blank sheet, designed to be used by collaborative teams of staff, students and employers who have already expressed a desire to create a work-integrated assessment. It is a diagnostic tool to help the team reflect on how a current assessment might be placed on the axes of the graph, and what changes might be made to move along these axes.

Isobel

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Multiple Assessment Points
Move to a more distributed pattern of assessment; consider introducing 'surprise' points
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Using multiple assessment points helps to develop reflective thinking, whilst 'surprise' points support task prioritisation.

Peer Feedback / Review
Include peer review and/or assessment as part of the overall process
Typically in higher education assessment feedback is solely produced by the teaching staff. In employment, however, much of the review process comes in the form of informal peer feedback, and from the clients that work has been done for.
Including this type of peer review and/or peer assessment formally within an assessment helps students to develop their critical thinking skills.

Varied Audiences
Aim to set audiences explicitly for each assessment point
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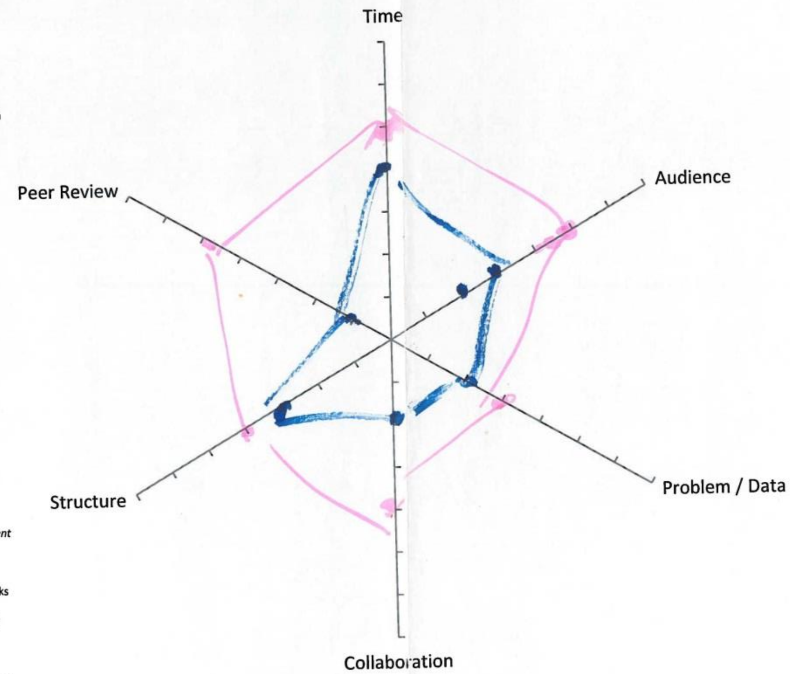

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Light Structure
Lightly structure the overall assessment; reward student approaches
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Using a light structure approach encourages students to derive these shorter term tasks and goals in order to solve a bigger problem.

Collaborative Working
Create teams of students from the outset
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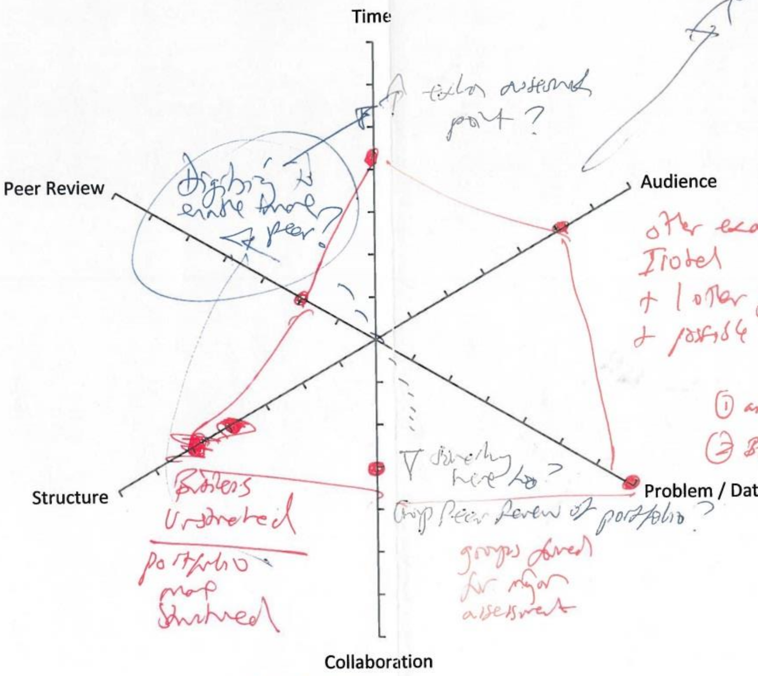
Encouraging students to work with in teams with peers helps build their collaborative skills, and develops their understanding of team roles and role flexibility.

Initial — Designed — Feedback

DRAFT, 17/07/12



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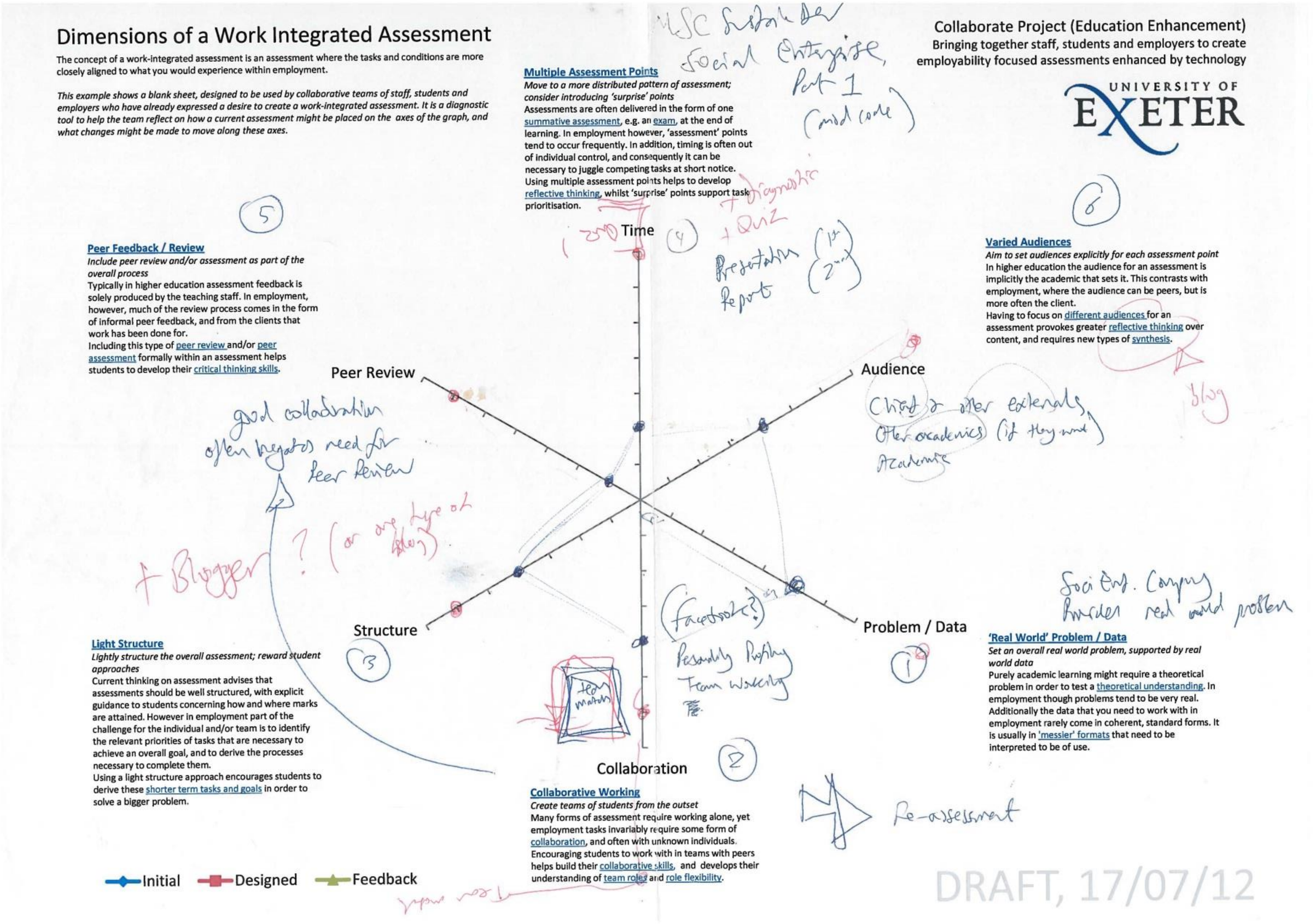

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Head of Practice of Management
12/10/12

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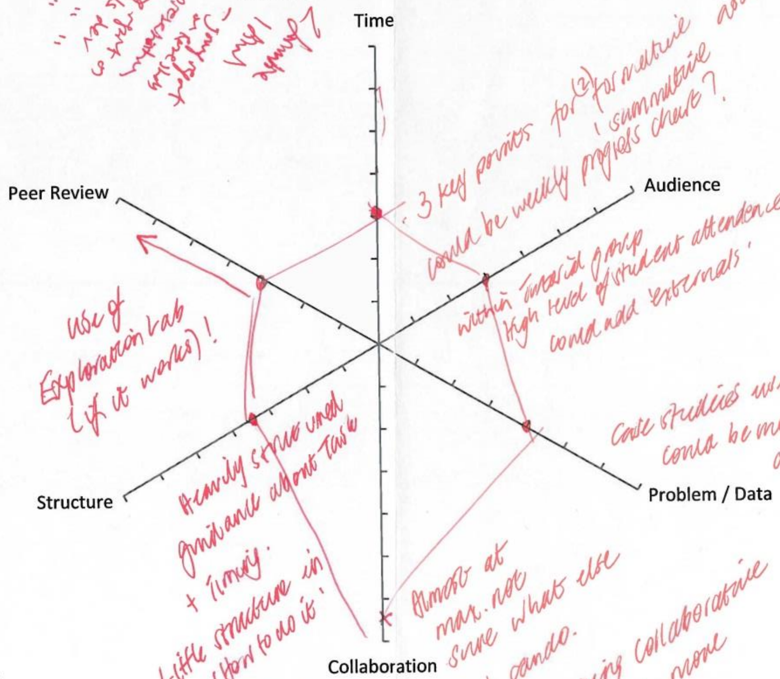

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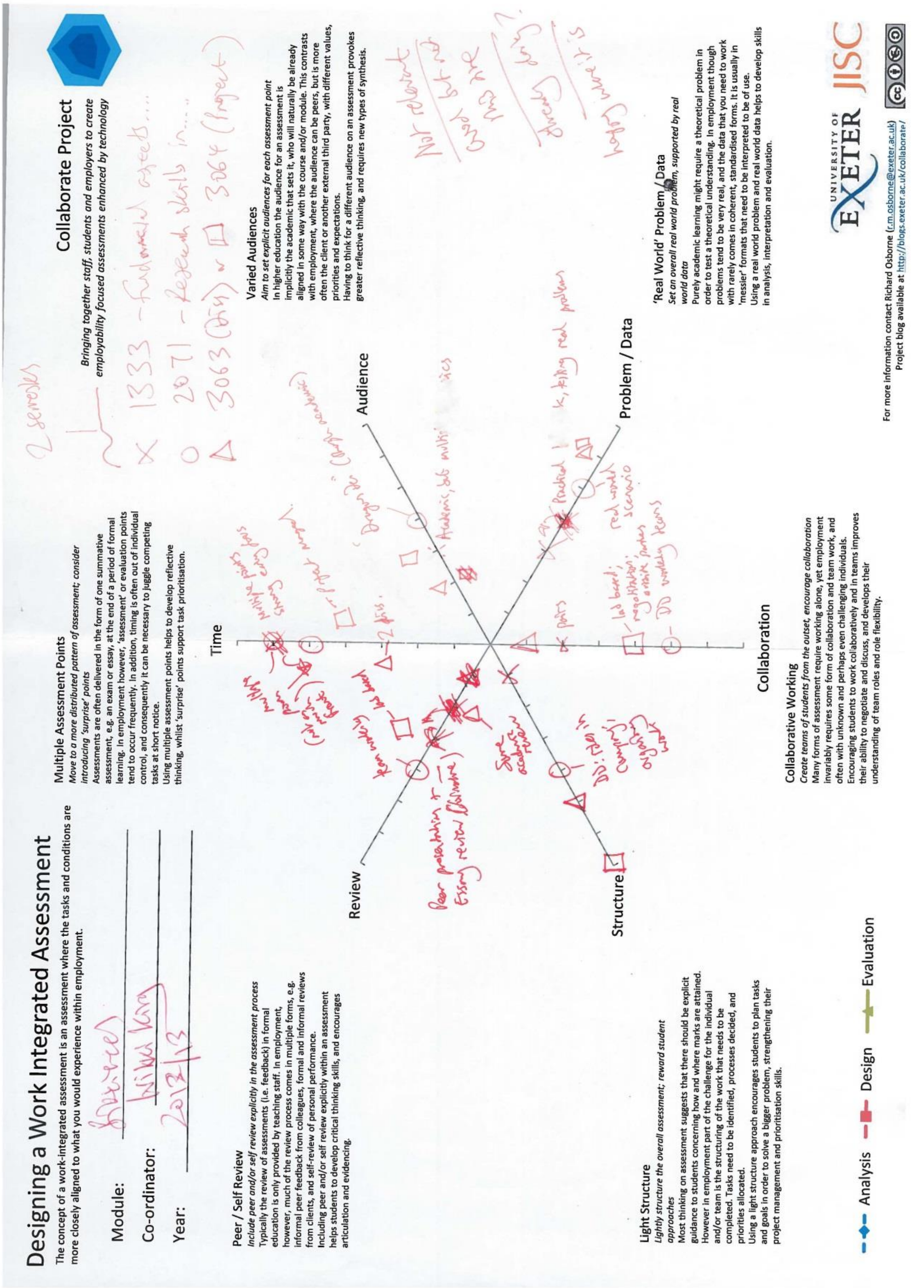
Initial — Designed — Feedback

DRAFT, 17/07/12



Designing a Work Integrated Assessment

The concept of a work-integrated assessment is an assessment where the tasks and conditions are more closely aligned to what you would experience within employment.

Module:

Co-ordinator:

Year: 2012/13

Peer / Self Review

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Including peer and/or self review explicitly within an assessment helps students to develop critical thinking skills, and encourages articulation and evidencing.

Light Structure

Lightly structure the overall assessment; reward student approaches
Most thinking on assessment suggests that there should be explicit guidance to students concerning how and where marks are attained. However in employment part of the challenge for the individual and/or team is the structuring of the work that needs to be completed. Tasks need to be identified, processes decided, and priorities allocated.
Using a light structure approach encourages students to plan tasks and goals in order to solve a bigger problem, strengthening their project management and prioritisation skills.

Multiple Assessment Points

Move to a more distributed pattern of assessment; consider introducing 'surprise' points
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Using multiple assessment points helps to develop reflective thinking, whilst 'surprise' points support task prioritisation.

Collaborative Working

Create teams of students from the outset, encourage collaboration
Many forms of assessment require working alone, yet employment invariably requires some form of collaboration and team work, and often with unknown and perhaps even challenging individuals.
Encouraging students to work collaboratively and in teams improves their ability to negotiate and discuss, and develops their understanding of team roles and role flexibility.

Collaborate Project

Bringing together staff, students and employers to create employability focused assessments enhanced by technology

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Having to think for a different audience on an assessment provokes greater reflective thinking, and requires new types of synthesis.

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Using a real world problem and real world data helps to develop skills in analysis, interpretation and evaluation.

Analysis — Design — Evaluation

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For more information contact Richard Osborne (r.m.osborne@exeter.ac.uk)
Project blog available at http://blogs.exeter.ac.uk/collaborate/

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Hazel Farrand

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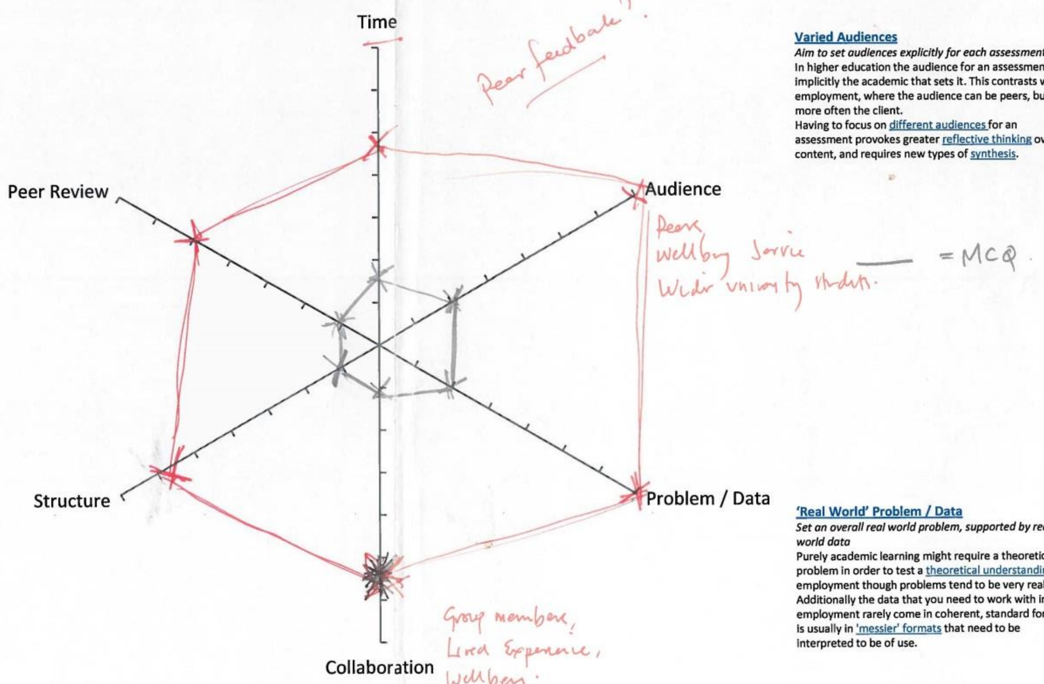

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Initial — Designed — Feedback

DRAFT, 17/07/12

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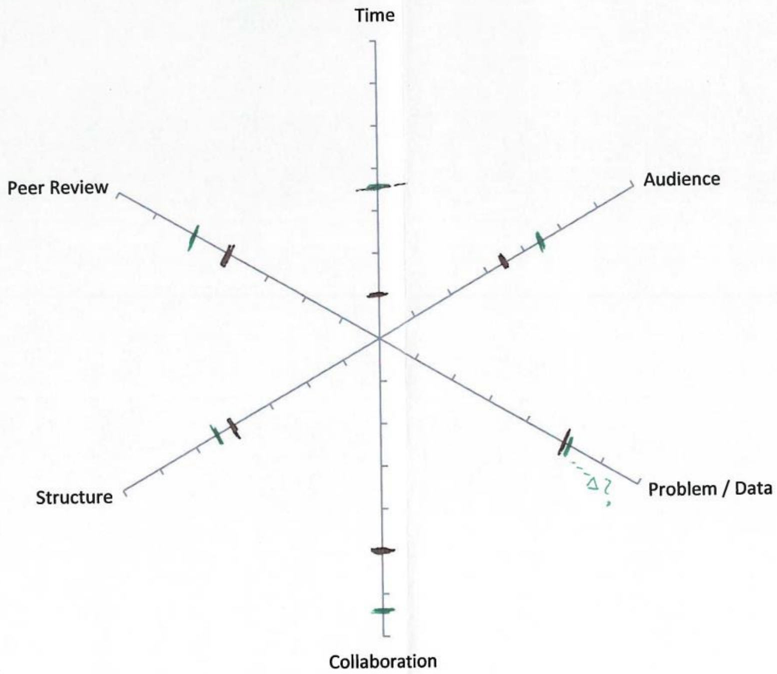

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The model is designed to be used in three stages: (1) An analysis stage to understand how the assessments for a module currently map to the model, followed immediately by; (2) A design stage where changes to the assessments are proposed that will create movement along the axes, followed much later by; (3) An evaluation stage after the assessments have run to assess the impact of designed changes.

Collaborate Project

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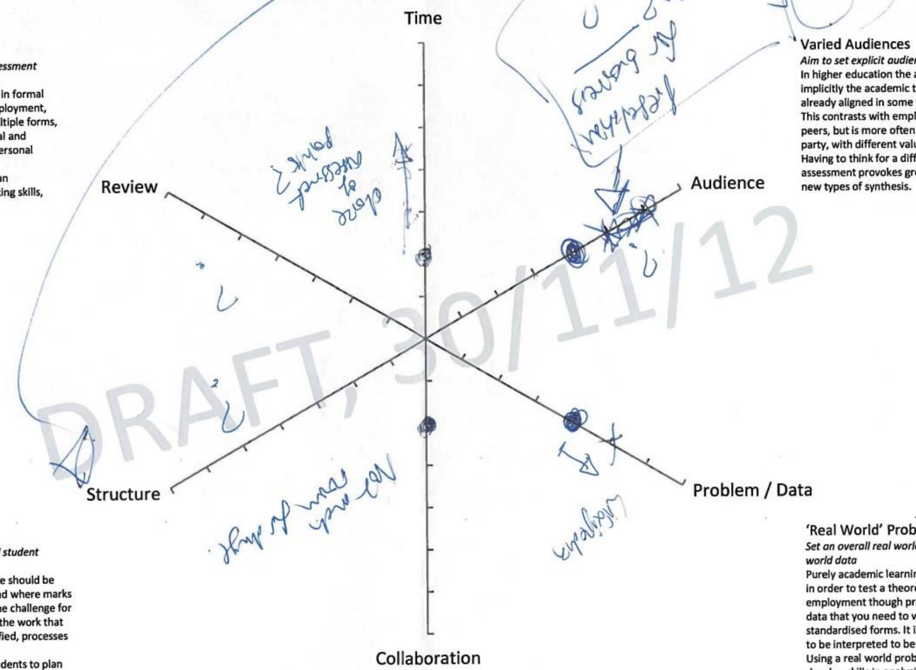
Having to think for a different audience on an assessment provokes greater reflective thinking, and requires new types of synthesis.

Sandy Allan
11/12/12

SS1001



Light Structure

Lightly structure the overall assessment; reward student approaches

Most thinking on assessment suggests that there should be explicit guidance to students concerning how and where marks are attained. However in employment part of the challenge for the individual and/or team is the structuring of the work that needs to be completed. Tasks need to be identified, processes decided, and priorities allocated.

Using a light structure approach encourages students to plan tasks and goals in order to solve a bigger problem, strengthening their project management and prioritisation skills.

Collaborative Working

Create teams of students from the outset, encourage collaboration

Many forms of assessment require working alone, yet employment invariably requires some form of collaboration and team work, and often with unknown and perhaps even challenging individuals.

Encouraging students to work collaboratively and in teams improves their ability to negotiate and discuss, and develops their understanding of team roles and role flexibility.

'Real World' Problem / Data

Set an overall real world problem, supported by real world data

Purely academic learning might require a theoretical problem in order to test a theoretical understanding. In employment though problems tend to be very real, and the data that you need to work with rarely comes in coherent, standardised forms. It is usually in 'messier' formats that need to be interpreted to be of use.

Using a real world problem and real world data helps to develop skills in analysis, interpretation and evaluation.

Analysis — Design — Evaluation

UNIVERSITY OF EXETER JISC

For more information contact Richard Osborne (r.m.osborne@exeter.ac.uk)
Project blog available at http://blogs.exeter.ac.uk/collaborate/

Dimensions of a Work Integrated Assessment

The concept of a work-integrated assessment is an assessment where the tasks and conditions are more closely aligned to what you would experience within employment.

This example shows a blank sheet, designed to be used by collaborative teams of staff, students and employers who have already expressed a desire to create a work-integrated assessment. It is a diagnostic tool to help the team reflect on how a current assessment might be placed on the axes of the graph, and what changes might be made to move along these axes.

Sarah Hodges

Collaborate Project (Education Enhancement)
Bringing together staff, students and employers to create employability focused assessments enhanced by technology

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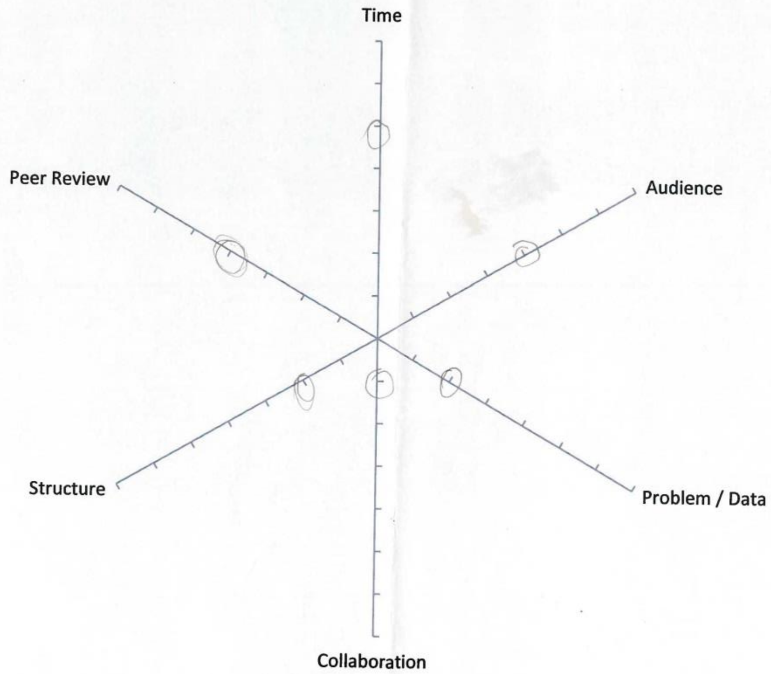
Multiple Assessment Points
Move to a more distributed pattern of assessment; consider introducing 'surprise' points
Assessments are often delivered in the form of one summative assessment, e.g. an exam, at the end of learning. In employment however, 'assessment' points tend to occur frequently. In addition, timing is often out of individual control, and consequently it can be necessary to juggle competing tasks at short notice.
Using multiple assessment points helps to develop reflective thinking, whilst 'surprise' points support task prioritisation.

Peer Feedback / Review
Include peer review and/or assessment as part of the overall process
Typically in higher education assessment feedback is solely produced by the teaching staff. In employment, however, much of the review process comes in the form of informal peer feedback, and from the clients that work has been done for.
Including this type of peer review and/or peer assessment formally within an assessment helps students to develop their critical thinking skills.

Varied Audiences
Aim to set audiences explicitly for each assessment point
In higher education the audience for an assessment is implicitly the academic that sets it. This contrasts with employment, where the audience can be peers, but is more often the client.
Having to focus on different audiences for an assessment provokes greater reflective thinking over content, and requires new types of synthesis.



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Collaborative Working
Create teams of students from the outset
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Encouraging students to work with in teams with peers helps build their collaborative skills, and develops their understanding of team roles and role flexibility.

Initial — Designed — Feedback

DRAFT, 17/07/12

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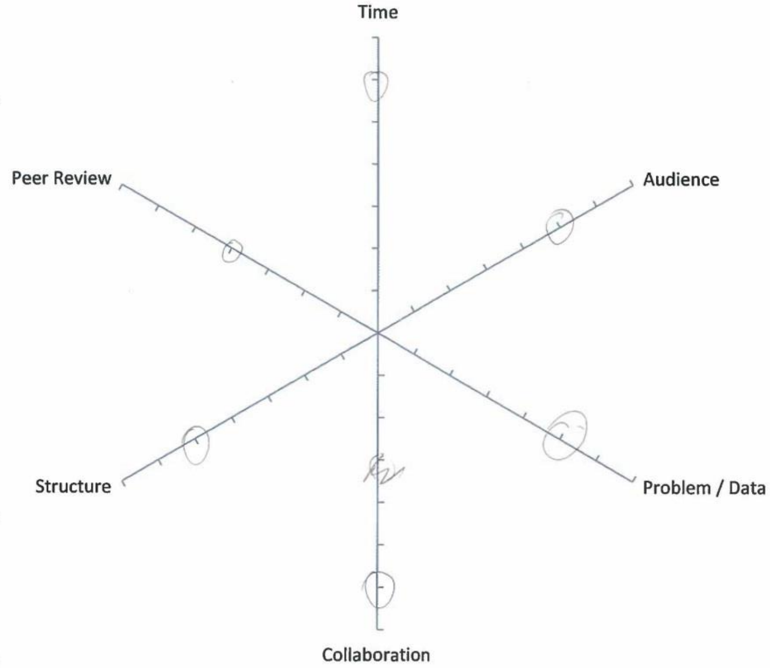

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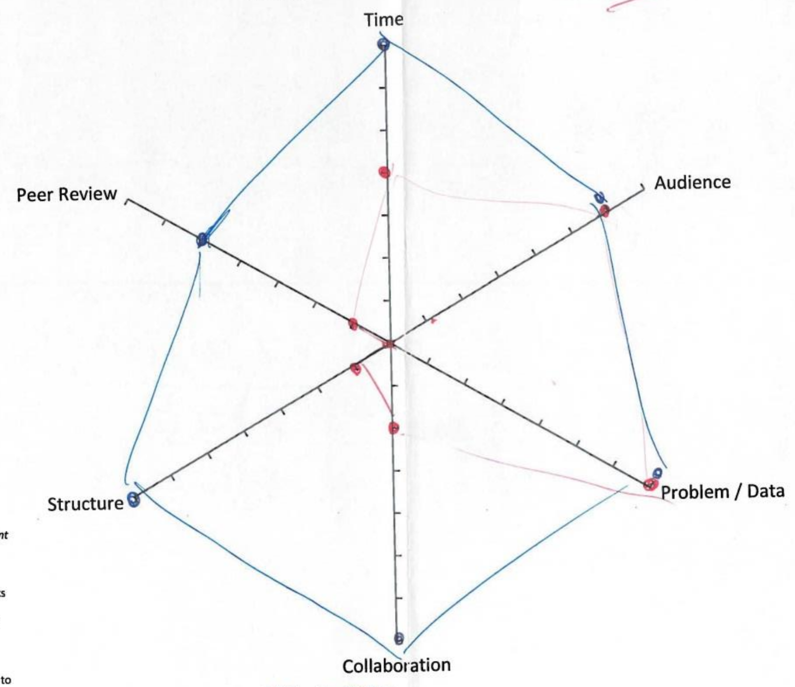

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UNIVERSITY OF EXETER

Tim Cooper
22/10/2017
HIC 2315

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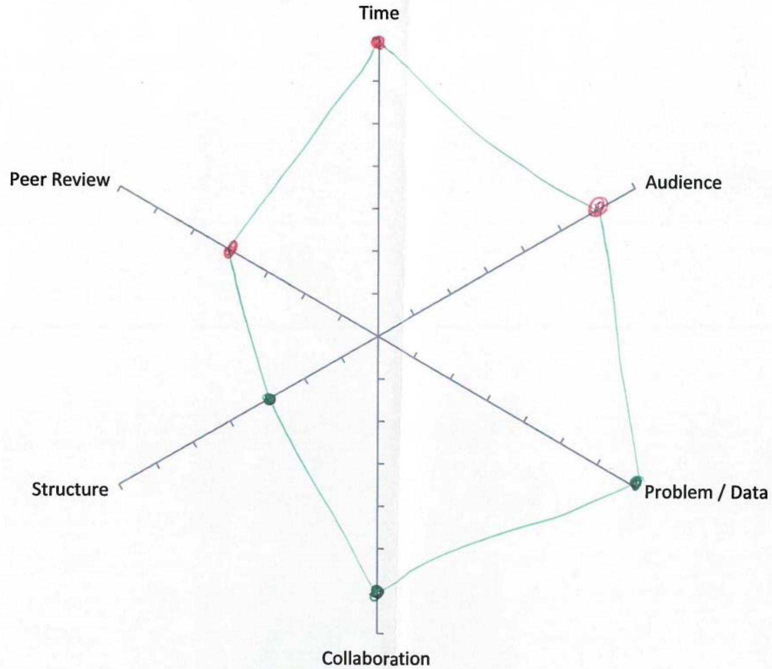

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Appendix E6: Guide to the Tech Trumps

Overview: What are Tech Trumps?

The tech trumps are pocket-sized cards in the top trump style which summarise how off-the-shelf and institutional technologies can be applied to the dimensions of work-integrated assessment model. They are designed to summarise the potential affordances of each digital technology in the context of the dimensions model: For example, technologies with a strong social presence would afford collaboration, or those that provide space for reply and discourse would afford peer review.

The cards have been designed to overcome a recurring problem when utilising modern digital technologies in educational settings: how to communicate the vast swathe of possible technological options to an audience with very disparate experiences and expectations of those technologies. By adopting the top trump metaphor, where items from a specific topic are reduced to a simple set of metrics which describe them, we hope to create an accessible starting point which will give students and staff alike an easy way to compare and contrast the potential benefits of a wide range of modern digital technologies in a simple and less intimidating fashion.

Please note that the Tech Trumps contains links to relevant external websites. Whilst we select these links carefully, we cannot guarantee, or be held responsible for, their quality or content.

How are Tech Trumps chosen?

The technologies that form each tech trump generally have to meet two criteria in order to be included:

- They must be free at the point of use (e.g. they might have a cost, but be institutionally provided), or have a significant and valuable free edition
- They must be available either on the web, or on the most common mobile operating systems currently in use (iOS and Android as of 2014)

Some long-standing technologies that do not meet this criteria are also currently included, e.g. Second Life, as they are familiar and mature.

Guide for creating/editing a tech trump

The tech trump cards are stored in a Google Fusion Table, which is a form of online database, and like all databases each card is represented by a number of fields which describe their properties. These fields are listed below, with a guide to the type of information which should be entered in each case. All fields should be completed.

Technology

This field is simply the name of the technology in question.

Example: “Question Mark Perception”

Thumbnail

This field should contain the URL to the logo of the technology in question. It can be in any standard web picture format (jpeg, gif, png, etc.). It will be automatically scaled by the top trump card, and displayed as an image on the front of the Top Trump.

It is recommended that a logo is sourced either from the technology’s website itself, or from a stable source such as Wikipedia.

Example: “http://www.zotero.org/static/images/theme/zotero.png

URL

The URL field should contain the website address, i.e. URL, of the technology in question.

Example: “http://www.citeulike.org”

Oneliner

This field should contain a ‘oneliner’ description of the technology in question, something that summarises the key aim of the technology in a single short sentence.

Example: “Open-source free Learning Management System from Google”

Description

This field should contain a more verbose description of the technology, which details its specific capabilities. Using the companies’ own descriptions is usually a good choice, though they may well need to be rewritten to reduce the explicit “marketing speak”. Wikipedia is also a good source for description text.

Example: “SketchUp is a 3D modelling program optimized for a broad range of applications such as architectural, civil, mechanical, film as well as video game design — and available in free as well as 'professional' versions. The program includes a drawing layout functionality, allows surface rendering in variable "styles," accommodates third-party "plug-in" programs enabling other capabilities (e.g. near photo-realistic rendering) and enables placement of its models within Google Earth.”

Star ratings

The star ratings summarise the affordances of the technology in relation to the dimensions of work-integrated assessment model. It should be noted that under the affordance model these will be the *theoretical* affordances provided by each technology in relation to the model. Whether the affordance is attended to in practice will depend on the individual learners: whether they have had the opportunity to discover the affordances, either through modelling or through exploration, and whether or not they have a specific need that the technology meets.

In order to decide on the specific star rating for each technology, a number of questions follow below. The purpose of these questions is to provoke thinking about how many stars a particular technology should be assigned for each dimension. Following the affordances model of educational technology use, the questions are focused around what each technology might *provide* or *furnish* for learners, in the context of each of the six dimensions of the model.

Even though a technology may not appear to have any relevance to a dimension, the stars are designed to be assigned on a scale of 1-5, therefore every card should have at least 1 star for each category.

In an ideal scenario, star ratings for each technology would be decided through small team discussions, and validated and extended through crowd sourcing techniques. This is not always achievable in practice; best efforts should be made to ensure that star ratings have been agreed by at least three individuals.

Dimension	**Question**	**Example**
Time	*Does the technology provide a way to create and manage related content over time?*	Example: diary formats, such as those used by blog tools, tend to be highly structured in time, providing an instant framework for multiple submissions and therefore self-reflection, so might rate 4 or 5 stars High = diary format Low = snapshot

Audience	*Does the technology provide a way to connect with new audiences?*	Example: YouTube provides a format in which content can be shared easily with audiences outside the institution, either at random or by conscious selection.
Problem / Data	*Does the technology provide a source of real world data and/or problems?*	Example: Wikipedia contains 'real world' articles on many topics, but also contains discussions about those topics which summarise issues, so can be a valuable source of topical debate.
Collaboration	*Does the technology provide the opportunity to co-create with others?*	Example: Google Drive is inherently built to be collaborative, and supports real-time viewing and editing between collaborators, so would score 5 stars.
Structure	*Does the technology provide structures for managing activities?*	Example: tools such as Trello are structured around tasks, milestones, deadlines - the bread-and-butter of project management - and also support automatic notification of events, so would score 5 stars.
Review	*Does the technology provide methods for commenting on previous contributions?*	Example: blogging tools such as Blogger and WordPress include the opportunity for commenting on posts, therefore providing an easy method for including review.

Licensing/Cost

The method by which the technology is licensed, and any costs involved with its use, should be included here.

Example: "Free"

University of Exeter Provided

If the technology is one provided by the University of Exeter, and is therefore University supported, enter "Yes" here, otherwise enter "No".

Example: Either "Yes" or "No"

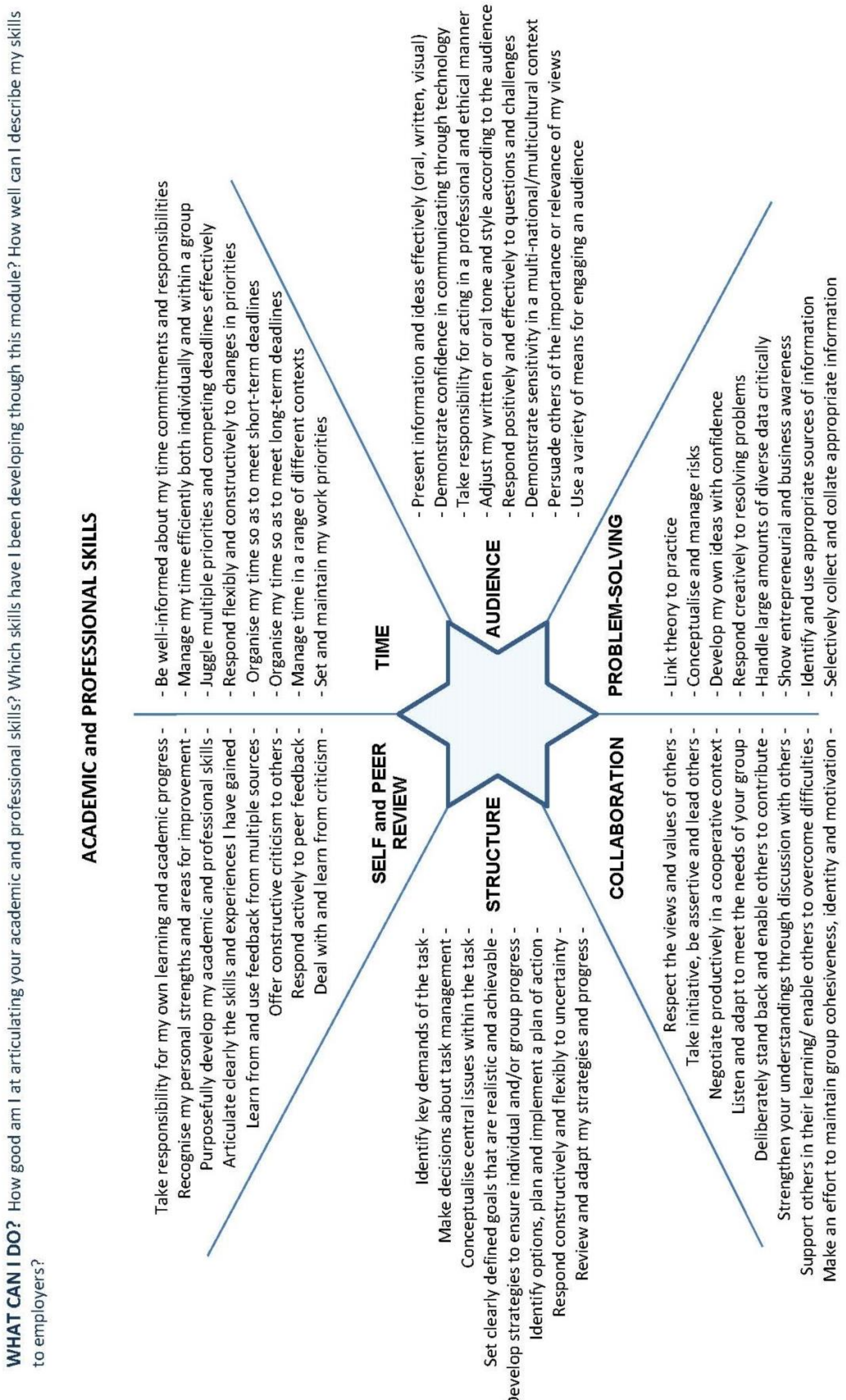
Complexity

This field should contain a rating of how complex the technology is to use, and is designed to be used in conjunction with a measure of the user's digital literacy (which can be carried out using the iTest), whether individually or as a cohort, in order to gauge whether or not a particular technology would be appropriate.

The field should contain "Low", "Medium" or "High", depending on how complex the technology is to use. Note: this is something of a subjective rating, and at the same time a particular technology might be used at different levels of complexity. Nonetheless a general level of complexity should be supplied in order to enable broad inclusion or exclusion of technologies as appropriate.

Example: Either "Low", "Medium" or "High"

Appendix E7: Alignment between skills and dimensions



Appendix E8: Skills Evaluation Scoring Sheet

Skills Evaluation: Scoring Sheet

Collaborate Project

Bringing together staff, students and employers to create employability focused assessments enhanced by technology

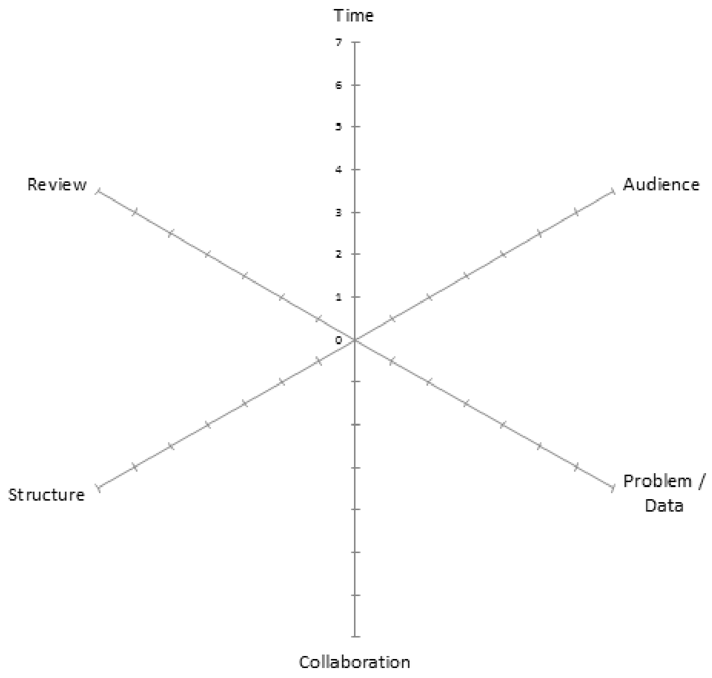
Module : Group: Date:

This skills evaluation scoring sheet is designed to be used in conjunction with the "what can we do" skills evaluation placemat and the 48 skill cards. It will summarise the responses in terms of the dimensions model for work integrated assessment.

To evaluate the overall score for each of the six dimensions of the model, as displayed on the right, the value of each card needs to be recorded.

1. Remove one card at a time, turning each over to reveal a dimension that it matches. Record the value of the card in the first available box below, i.e. if the card has been placed in the box marked 'a little', record a score of '3'.
2. Once all the cards have been done in this way, add up the total and place this in the sum box.
3. Now divide by 8 to give the mean score.
4. Finally mark this score on the radar diagram on the right to see the overall picture of skills development in the context of the model.

									∑		x̄
EXAMPLE	3	5	7	1	2	3	4	2	27	/ 8 =	3.4
TIME										/ 8 =	
AUDIENCE										/ 8 =	
PROBLEM /DATA										/ 8 =	
COLLABORATION										/ 8 =	
STRUCTURE										/ 8 =	
REVIEW										/ 8 =	



Appendix E9: List of technologies

Technology	URL	One line description
Acrobat Reader	http://get.adobe.com/reader	Adobe PDF (Portable Document Format) reader
Acrobat.com	https://www.acrobat.com	Save your files in the cloud and access them from any device
Adobe Connect	http://www.adobe.com/uk/products/adobeconnect.html	Web conferencing software that provides secure web meeting space
Audioboo	http://audioboo.fm	A mobile and web platform that allows you to record and share audio
Azendoo	https://en.azendoo.com	Organise your life, sync your team and share your projects, all in one place
Bambuser	http://bambuser.com	Broadcast what is happening around you and chat with your viewers live.
Bing Maps	http://www.bing.com/maps	View an interactive map and get turn by turn driving directions.
Blogger	http://www.blogger.com	Blogging tool with beautiful, customizable templates and layouts
Box of Broadcasts	http://bobnational.net	Enables you to record and view TV and radio online from over 50 free-to-air channels in the UK
Chirp	http://chirp.io	Chirp sings information from one phone to another.
CiteULike	http://www.citeulike.org	Search, organize, and share scholarly papers.
Confluence	http://www.atlassian.com/software/confluence/	Confluence is a team and content collaboration tool that uses a wiki design

Dbee	http://www.dbee.me	Social network focused on debating issues.
Delicious	http://delicious.com	Delicious is an online social bookmarking service
Diigo	http://www.diigo.com	Diigo is a powerful research tool and a knowledge-sharing community.
Doodle	http://doodle.com	Doodle helps scheduling meetings and other appointments.
Dropbox	http://www.dropbox.com	Web based file storage, working and sharing
ELE	http://vle.exeter.ac.uk	ELE is the University of Exeter's Virtual Learning Environment
Elgg	http://elgg.org	Open source social networking engine
Evernote	http://www.evernote.com	Web based notetaking service with powerful mobile apps
Facebook	http://www.facebook.com	Social network with powerful collaboration and extensibility
Flickr	http://www.flickr.com	Flickr is an online photo management and sharing application
Google Alerts	http://www.google.com/alerts	Email updates from relevant Google results based on your queries
Google Analytics	http://www.google.com/analytics/	Web analytics to measure your websites performance
Google Drive	https://drive.google.com	Web based file collaboration and storage
Google Earth	http://earth.google.co.uk	3D simulation of planet earth
Google Maps	https://www.google.co.uk/maps	Zoomable maps focused on an address or post code

Google Scholar	http://scholar.google.co.uk	Search scholarly literature across many disciplines and sources
Google+	https://plus.google.com	Google+ aims to make sharing on the web more like sharing in real life
IFTTT	https://ifttt.com	Put the internet to work for you - If This Then That ...
Jabber	http://www.jabber.org	Jabber is a free instant messaging and presence service
Jing	http://www.techsmith.com/jing.html	Downloadable software that captures your computer screen
LinkedIn	http://linkedin.com	Identity management for building a professional network
OpenClass	http://www.openclass.com	Open source free Learning Management System from Google and Pearson
Padlet	http://padlet.com	Digital paper for posting anything you like
PeerMark	http://turnitin.com/en_us/products/peermark	PeerMark is a peer review tool built into the Turnitin suite
PeerWise	http://peerwise.cs.auckland.ac.nz	Peer review structured through assessment questions
Picasa	https://picasaweb.google.com	Fast and easy photo sharing from Google.
Pinterest	https://uk.pinterest.com	Image based content sharing website
Pocket	http://getpocket.com	Web service that allows you to save and later view web discoveries
Popcorn Maker	https://popcorn.webmaker.org	Online tool that makes it easy to enhance, remix and share web video
Prezi	http://prezi.com	Web-based presentation software using a single zoomable canvas

Scoop.it	http://www.scoop.it	Easily create and curate an online magazine/portfolio from the web
Screencast-O-Matic	http://www.screencast-o-matic.com	One-click screen capture recording via the web
Screenr	http://www.screenr.com	Instant screencasts: Just click record
Scrible	http://www.scrible.com	Web page highlighter and annotator
Second Life	http://www.secondlife.com	3D virtual world where users can socialize, connect and create
SkyDrive	https://skydrive.live.com	Access your files anywhere and share with anyone.
Skype	http://www.skype.com	Video and voice calls, instant messaging and file sharing
Slideshare	http://www.slideshare.net	Presentation file storage for private or public use
SoundCloud	http://soundcloud.com	Create, record and share sound
Storify	http://storify.com	Storify helps its users tell stories by curating social media.
Survey Monkey	http://www.surveymonkey.com	Create and publish online surveys in minutes
Tagxedo	http://www.tagxedo.com	Word clouds with styles
Team-Match	http://www.team-match.com	Team building on the Web: Quick, Effective and Fun
Trello	https://trello.com	Organizes your projects into boards and your tasks into cards
Tumblr	https://www.tumblr.com	A feature rich and free blog hosting platform
Twitter	http://www.twitter.com	Real-time social network limited to 140 characters

Vimeo	http://vimeo.com	High-quality video uploading and sharing website
WhatsApp	http://www.whatsapp.com	Simple. Personal. Real Time Messaging
Wikipedia	http://www.wikipedia.org	Wikipedia is a free online encyclopaedia
Wikipedia Books	http://en.wikipedia.org/ wiki/Help:Books	Books, digital or real, created from Wikipedia content.
Wikispaces	http://www.wikispaces.com	Simple and easy to use wikis
Wordle	http://www.wordle.net	Visualisations of word frequency from larger sections of text
WordPress	http://www.wordpress.com	Online blogging tool, with support for multiple designs and many plugins
Wunderlist	https://www.wunderlist.com	Manage and share your to-do lists
Yammer	http://www.yammer.com	Yammer is an Enterprise Social Network
YouTube	http://www.youtube.com	Video-sharing website on which users can upload, share, and view videos
Zoho	http://www.zoho.com	Suite of online web applications offering easy collaboration
Zotero	http://www.zotero.org	Research tool that helps you gather, organize, and analyse sources

Appendix E10: Interview Questions (Evaluation)

The overall model of Collaborate is to create the conditions under which students will develop employability skills, attributes and awareness without explicit reference to these skills, attributes and awareness. Instead, various ‘dimensions’ are built into the assessment that provoke students to discover new ways of working and thinking for themselves, with specific technologies chosen to help scaffold these behaviours.

These evaluation questions are designed to prompt those involved in redesigned assessments using the Collaborate approach to reflect on their experience, and hence draw out key aspects of the approach which have been particularly effective.

Stakeholder specific questions

Student

You’ve recently experienced a more innovative form of assessment as part of your studies at Exeter ...

... overall, how do you think this form of assessment compares with a more ‘standard’ form of assessment?

... did the way the assessment was structured change the way you completed it?

... how do you feel the assessment has developed you in terms of your employability?

... what value did the use of technologies bring to the assessment?

... what were the highlights of the assessment from your perspective?

... what would you change about the assessment if you had the chance?

Academic Staff

You've recently been involved in trialling work-integrated assessment as part of your academic practice at Exeter ...

... why did you choose to try work-integrated assessment over more standard forms of assessment?

... what challenges did work-integrated assessment present over more standard forms of assessment?

... what would you change about work-integrated assessment if you had the chance?

... how do you think the use of this form of assessment has impacted your students?

... how has this form of assessment impacted you in terms of time and resources?

Learning Technologists

You're already involved in many different ways of supporting and embedding learning technologies at your College ...

... what new technical challenges did work-integrated assessment present you with?

... what issues arose when trying to combine off the shelf technologies with institutional technologies?

... which technologies proved themselves most useful in supporting work-integrated assessment?

... which technologies were most problematic in supporting work-integrated assessment?

... what would you change about the assessment if you had the chance?

Employability Officers

You're already involved in many different ways of addressing employability at your College ...

... how does the concept of a work-integrated assessment fit with these other employability initiatives?

... what value does a work-integrated assessment offer that other employability initiatives do not?

... what would you change about work-integrated assessment if you had the chance?

Employers

You've recently been involved in a work-integrated assessment, in partnership with the University of Exeter ...

... why did you decide to become involved in work-integrated assessment?

... what benefits has your involvement in work-integrated assessment brought to your work?

... how easy or difficult has it been to dedicate time and resources to involvement with the University?

... what would you change about the assessment if you had the chance?

Technology specific questions

You used XXX technology during your studies ...

... what did this technology provide you with in particular?

... what did the technology give back to you?

Appendix E11: Final Dimensions Model

Designing a Work Integrated Assessment

The concept of a work-integrated assessment is an assessment where the tasks and conditions are more closely aligned to what you would experience within employment.

Module: ______________________

Co-ordinator: ______________________

Year: ______________________

Collaborate Project

Bringing together staff, students and employers to create employability focused assessments enhanced by technology

Multiple Assessment Points

Move to a more distributed pattern of assessment; consider introducing 'surprise' points

Assessments are often delivered in the form of one summative assessment, e.g. an exam or essay, at the end of a period of formal learning. In employment however, 'assessment' or evaluation points tend to occur frequently. In addition, timing is often out of individual control, and consequently it can be necessary to juggle competing tasks at short notice.

Using multiple assessment points helps to develop reflective thinking, whilst 'surprise' points support task prioritisation.

Peer / Self Review

Include peer and/or self review explicitly in the assessment process

Typically the review of assessments (i.e. feedback) in formal education is only provided by teaching staff. In employment, however, much of the review process comes in multiple forms, e.g. informal peer feedback from colleagues, formal and informal reviews from clients, and self-review of personal performance.

Including peer and/or self review explicitly within an assessment helps students to develop critical thinking skills, and encourages articulation and evidencing.

Varied Audiences

*Aim to set explicit **audiences for each assessment point***

In higher education the audience for an assessment is implicitly the academic that sets it, who will naturally be already aligned in some way with the course and/or module. This contrasts with employment, where the audience can be peers, but is more often the client or another external third party, with different values, priorities and expectations.

Having to think for a different audience on an assessment provokes greater reflective thinking, and requires new types of synthesis.

Time

Review

Audience

Structure

Problem / Data

Collaboration

Overview

This assessment redesign sheet is designed to be used by collaborative teams of staff, students and/or employers who have already expressed a desire to create a work-integrated assessment. Six 'dimensions' are shown which are the hallmarks of a work-integrated assessment.

The sheet is a thinking tool to help the design team reflect on how a current assessment might be marked on the six dimensions of the radar chart, and what changes might be made to move along these six dimensions.

The model is designed to be used in three stages:

1) An analysis stage to understand how the assessments for a module currently map to the dimensions, followed immediately by;
2) A design stage where changes to the assessments are proposed that will create movement along the dimensions, followed by;
3) An evaluation stage after the assessments have run to assess the impact of designed changes.

Light Structure

Lightly structure the overall assessment; reward student approaches

Most thinking on assessment suggests that there should be explicit guidance to students concerning how and where marks are attained. However in employment part of the challenge for the individual and/or team is the structuring of the work that needs to be completed. Tasks need to be identified, processes decided, and priorities allocated.

Using a light structure approach encourages students to plan tasks and goals in order to solve a bigger problem, strengthening their project management and prioritisation skills.

'Real World' Problem / Data

Set an overall real world problem, supported by real world data

Purely academic learning might require a theoretical problem in order to test a theoretical understanding. In employment though problems tend to be very real, and data rarely comes in coherent, standardised forms. It is usually in 'messier' formats that need to be interpreted to be of use.

Using a real world problem and real world data helps to develop skills in analysis, interpretation and evaluation.

Collaborative Working

Create teams of students from the outset, encourage collaboration

Many forms of assessment require working alone, yet employment invariably requires some form of collaboration and team work, and often with unknown and perhaps even challenging individuals. Encouraging students to work collaboratively and in teams improves their ability to negotiate and discuss, and develops their understanding of team roles and role flexibility.

Analysis — Design — Evaluation

UNIVERSITY OF EXETER JISC

For more information contact Richard Osborne (r.m.osborne@exeter.ac.uk)
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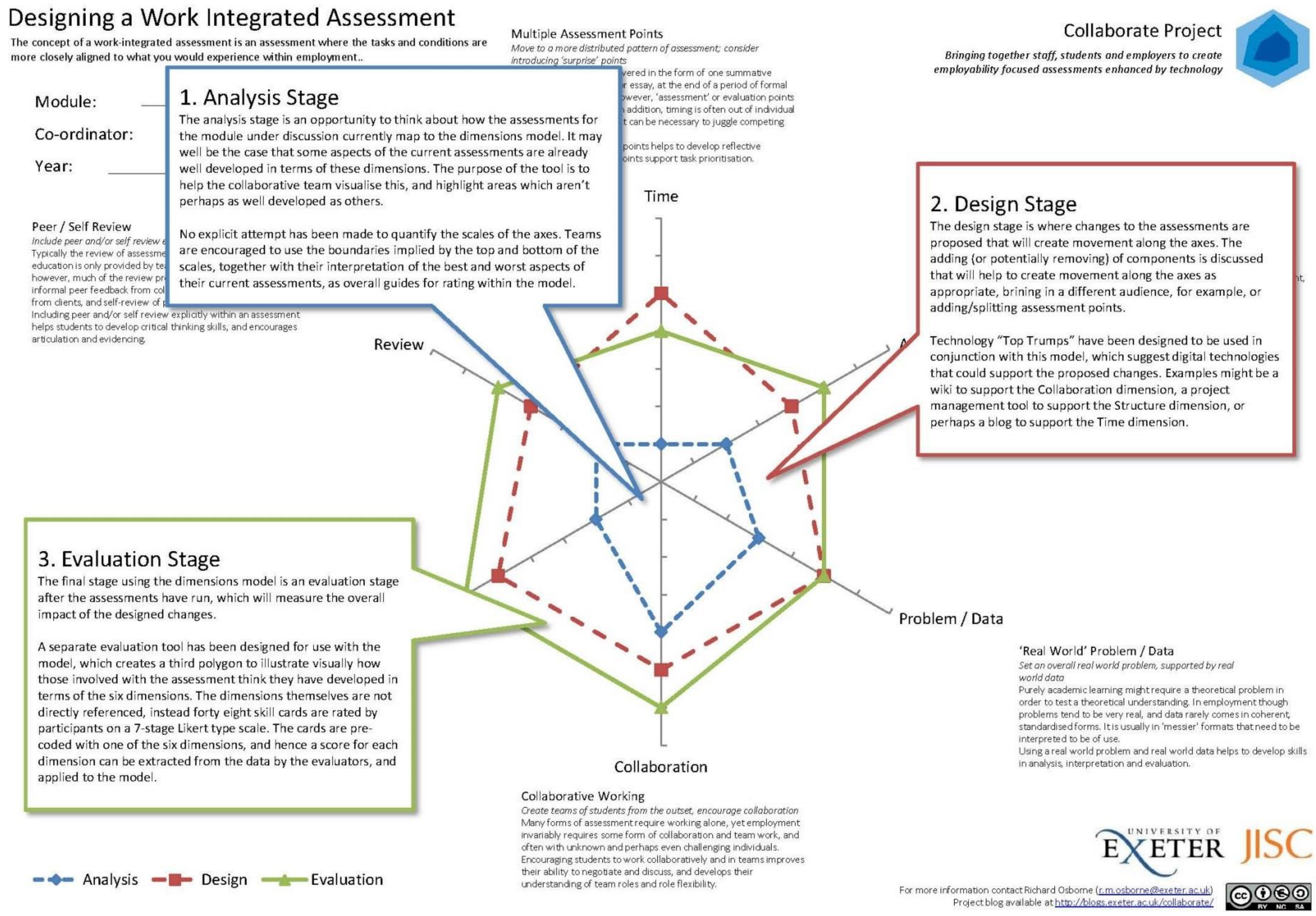
Designing a Work Integrated Assessment
The concept of a work-integrated assessment is an assessment where the tasks and conditions are more closely aligned to what you would experience within employment..
Module:
Co-ordinator:
Year:
Multiple Assessment Points
Move to a more distributed pattern of assessment; consider introducing 'surprise' points
Collaborate Project
Bringing together staff, students and employers to create employability focused assessments enhanced by technology
1. Analysis Stage
The analysis stage is an opportunity to think about how the assessments for the module under discussion currently map to the dimensions model. It may well be the case that some aspects of the current assessments are already well developed in terms of these dimensions. The purpose of the tool is to help the collaborative team visualise this, and highlight areas which aren't perhaps as well developed as others.
No explicit attempt has been made to quantify the scales of the axes. Teams are encouraged to use the boundaries implied by the top and bottom of the scales, together with their interpretation of the best and worst aspects of their current assessments, as overall guides for rating within the model.
Peer / Self Review
Including peer and/or self review explicitly within an assessment helps students to develop critical thinking skills, and encourages articulation and evidencing.
Time
Review
Problem / Data
Collaboration
2. Design Stage
The design stage is where changes to the assessments are proposed that will create movement along the axes. The adding (or potentially removing) of components is discussed that will help to create movement along the axes as appropriate, brining in a different audience, for example, or adding/splitting assessment points.
Technology "Top Trumps" have been designed to be used in conjunction with this model, which suggest digital technologies that could support the proposed changes. Examples might be a wiki to support the Collaboration dimension, a project management tool to support the Structure dimension, or perhaps a blog to support the Time dimension.
3. Evaluation Stage
The final stage using the dimensions model is an evaluation stage after the assessments have run, which will measure the overall impact of the designed changes.
A separate evaluation tool has been designed for use with the model, which creates a third polygon to illustrate visually how those involved with the assessment think they have developed in terms of the six dimensions. The dimensions themselves are not directly referenced, instead forty eight skill cards are rated by participants on a 7-stage Likert type scale. The cards are pre-coded with one of the six dimensions, and hence a score for each dimension can be extracted from the data by the evaluators, and applied to the model.
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Analysis
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Designing a Work Integrated Assessment

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Module:

Co-ordinator:

Year:

EXAMPLE

Collaborate Project

Bringing together staff, students and employers to create employability focused assessments enhanced by technology

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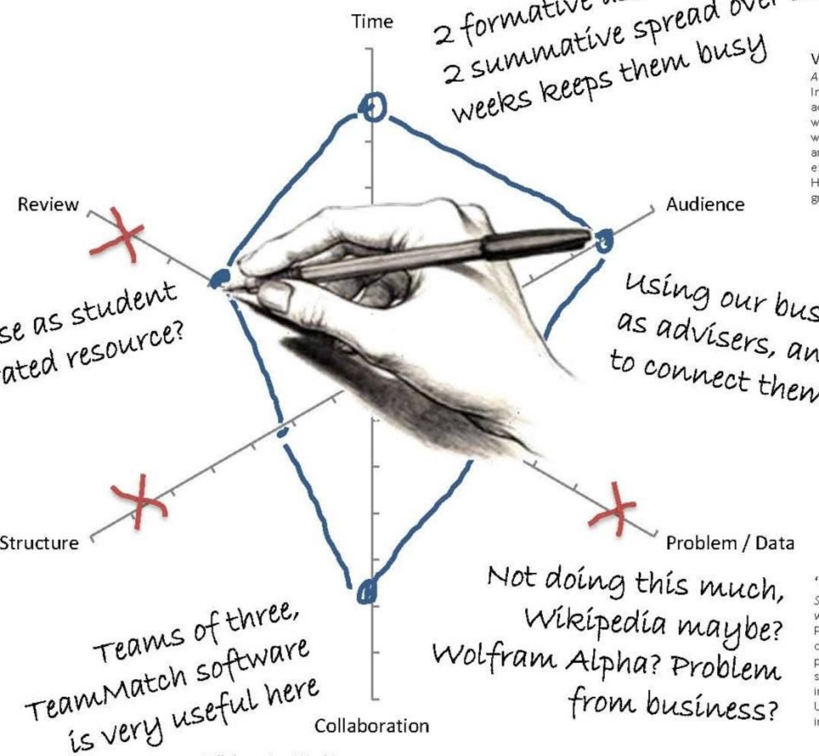

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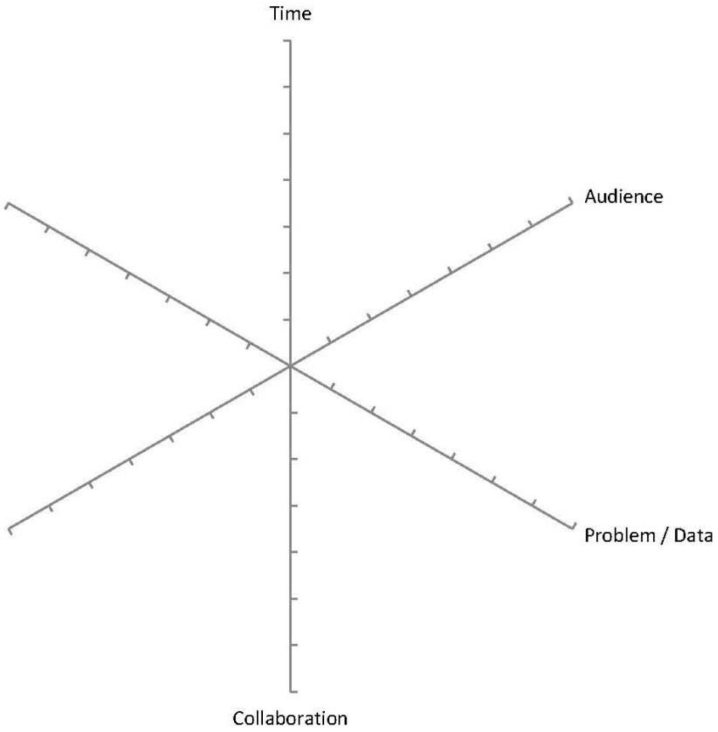

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